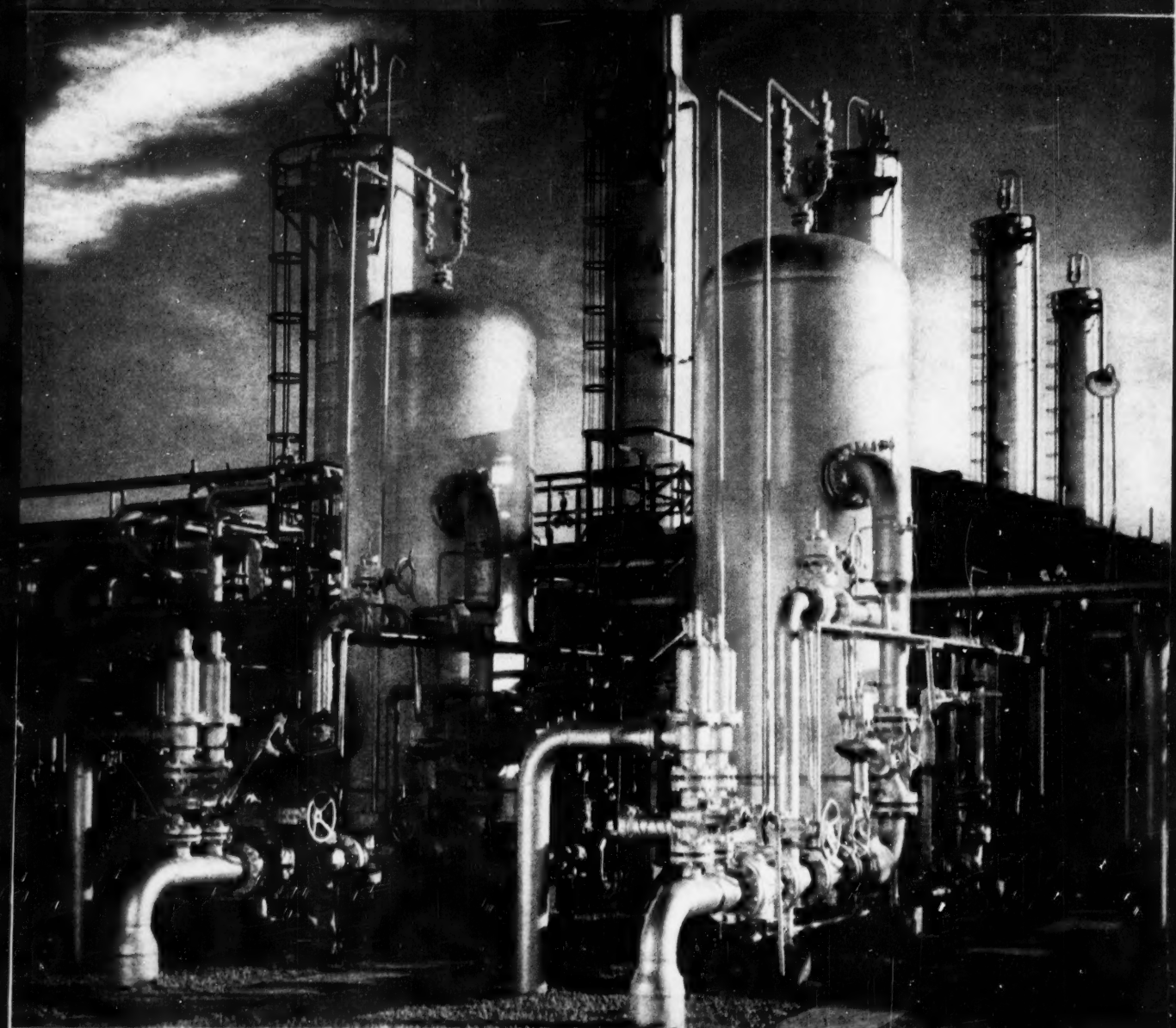
Instruments *and* **AUTOMATION**



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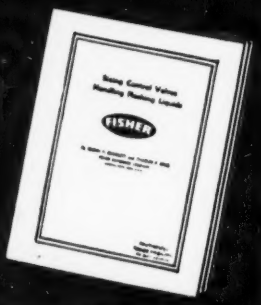

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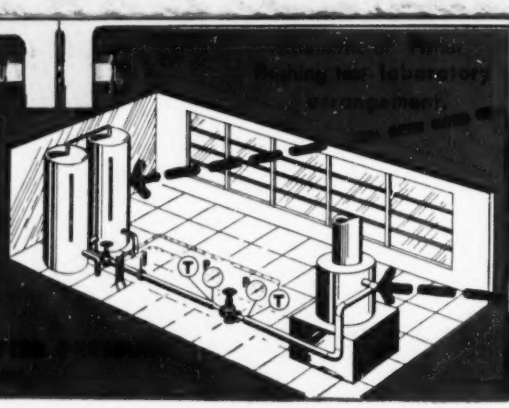

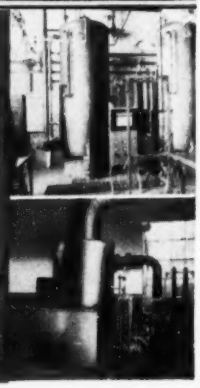

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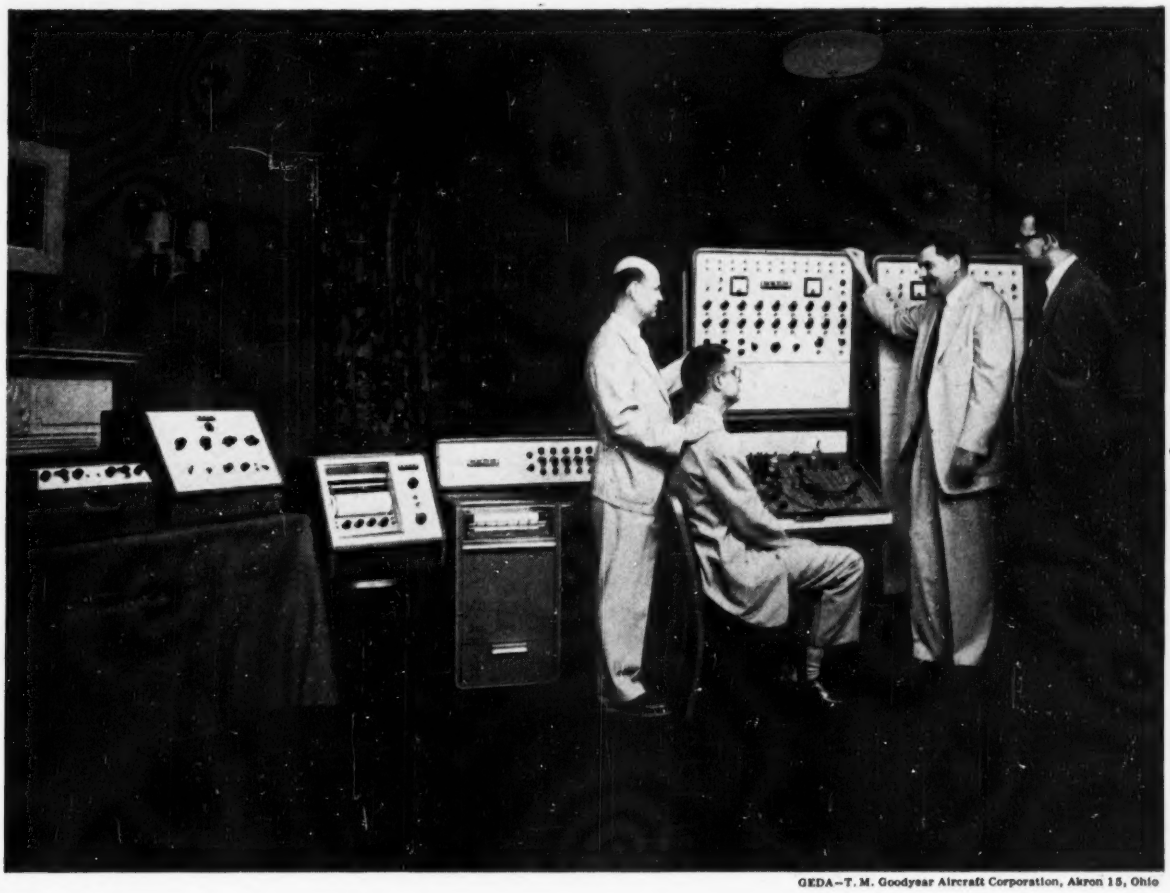
HOW TO MAKE WILD IDEAS WORTH-WHILE



GEDA—T. M. Goodyear Aircraft Corporation, Akron 15, Ohio

A WILD idea is only "wild" in terms of the time, talent and money it takes to determine whether or not it has merit.

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1 **0-1500F TEMPERATURE RANGE** of the General Electric hand pyrometer makes possible a wide variety of temperature checks with but the one instrument. Surface, liquid, gas, and molten-metal temperatures are readily measured. Automatic cold-junction compensation assures consistently accurate readings. The strong, lightweight, plastic case is dust-tight, moisture-resistant, and protects against breakage. Price, including case, two extension arms, and three tips, is **$191.10***.

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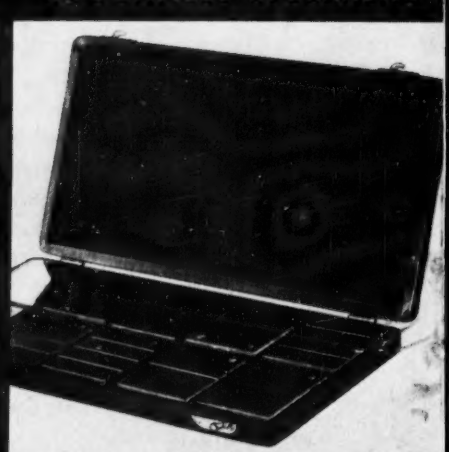

HANDY, POCKET-SIZE scales enable engineers and draftsmen to specify precise machine finishes, and to provide machine operators and inspectors with a standardized checking tool. Price is **$20.12***.

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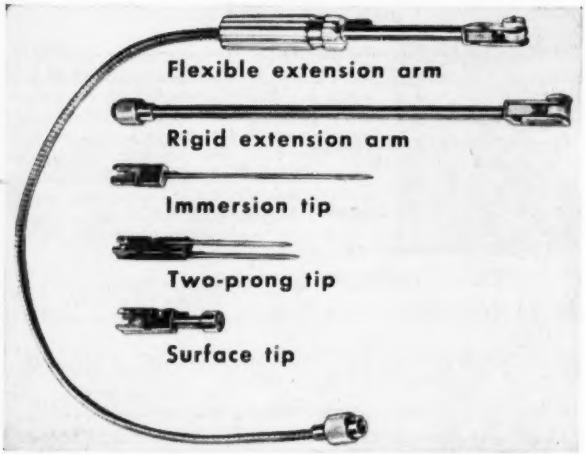
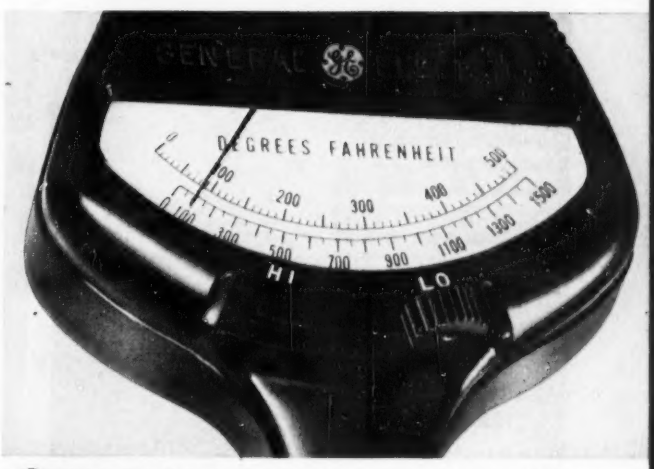
For more information circle **3** on inquiry card.

G-E Hand Pyrometer with Dual Range Provides Simplified, Time-saving Temperature Measurement

CONVENIENT—VERSATILE—DURABLE



2 **EXTENSION ARMS,** 14-inch rigid arm or the 34-inch flexible arm, permit the instrument to be held in a convenient, readable position. Tips can be interchanged without stopping for time-consuming recalibration of the instrument.



3 **DUAL RANGE,** the G-E hand pyrometer is designed for a maximum number of applications at a minimum cost. Just flick the HI-LO switch to choose the scale to suit the application. Scales are direct reading, 0-500F and 0-1500F.

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ZAHN VISCOSIMETER

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- ☐ Roughness Scales and Specimens (GEC-774)
- ☐ Infrared Meter (GEC-953)
- ☐ Zahn Viscosimeter (GEC-339)

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HIGH-RANGE RADIANT ENERGY measurements, up to 10 watts per square inch, make the G-E infrared meter a valuable aid in quality control of products requiring infrared processing. Price is **$67.47*.**

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Instruments and AUTOMATION

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By Kenneth G. Oliver

COVER STORY

Full nozzle type safety-relief valves manufactured by the Farris Engineering Corp., Palisades Park, New Jersey (shown in the foreground of the cover picture) are but a few of the many Farris Valves playing an important part in protecting Shell Oil's Elk City, Oklahoma gas-cycling plant.

Safety valves in this installation range from 1- to 6-inch inlet size for relieving pressures of 50 to 1100 psig.

The valves shown are set to relieve at 950 psig. on lines feeding to high-pressure absorbers—which process the entire well effluent at Elk City, handling 225,000 mcfd of gas and 20,000 b/d of crude oil.

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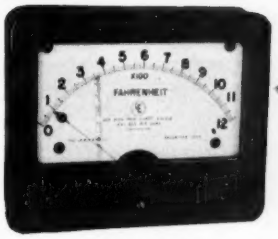
AUTOMOTIVE AND INDUSTRIAL TEMPERATURE MEASURING EQUIPMENT

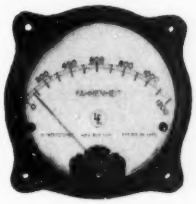
Sturdy Dependable Indicators —Suitable For Use In Moving Vehicles or For Permanent Installation

This instrument has been used extensively by the leading motor-car manufacturers for road testing on the "Proving Grounds" — where performance counts. Housed in a rectangular bakelite case, this reliable, fully compensated pyrometer is furnished with 6 in. hand drawn scales for greater accuracy. The Model 58PY is available for use with all standard thermocouple materials, in many ranges to suit the most exacting application.



MODEL 58PY

Manufactured with the same type of movement as our aircraft pyrometers, the Model 23B pyrometer is well suited for use in moving vehicles and has been successfully used in many marine diesel installations for measuring exhaust temperatures. It is housed in a 4 in. round bakelite case that is flanged for panel mounting, and is available in several ranges for use with various thermocouple materials.



MODEL 23B

The Model 20B series of indicators are patterned after our standard aircraft instruments and are supplied with 3" round steel cases suitable for panel installation. These compact, sturdy indicators have 2⅛ in. scales, are fully cold-end compensated and are available in many ranges for use with various thermocouple materials.

MODEL 20B

The Model 62RT4F resistance thermometer is a sturdy easy-to-read instrument with a 6 in. hand drawn scale. It is suitable for use in moving vehicles and is excellent for flight-test work. It is operated by an ordinary dry cell and is calibrated to standard "AN" bulb curves for various ranges in fahrenheit or centigrade.

MODEL 62RT4

THERMOCOUPLES for use with the above indicators are available in many styles for special applications. We have developed a complete line of aircraft, industrial and automotive thermocouples and would be pleased to offer our recommendation for your application.

THERMOCOUPLE LEAD WIRE for connecting thermocouples to the indicators is manufactured in iron-constantan, copper-constantan or chromel-alumel material with standard and special insulation. Use Lewis lead-wire with Lewis instruments and thermocouples for best results.

RESISTANCE BULBS for use as sensing elements for the 62RT4 thermometers are available in several types for various applications, for measuring free air or liquid temperatures. We invite inquiries on your application.

THE LEWIS ENGINEERING CO.

Specialists in Electrical Temperature Measurements

NAUGATUCK, CONNECTICUT

For more information circle **5** on inquiry card.

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Consolidated 7-300 *recording galvanometers*

unequalled for performance and quality

Products of a long range research program, CEC's new 7-300 series galvanometers incorporate better balancing techniques, new construction materials and a completely redesigned suspension system. The new 7-300 galvanometers are entirely new in design but fit all existing oscillographs, bringing increased control over linearity, sensitivity, damping, balance and stability. Smooth top-post rotation allows effortless, precise location of galvanometer light-spots on the record. Bodies are precision machined from solid stock for maximum strength, stability and ruggedness. Brass-tipped pole pieces, brazed in place under a hydrogen atmosphere, permit easy installation without forcible snapping into the magnetic block. Fourteen models give the new 7-300 series complete coverages of frequency ranges from 0 to 3000cps. For helpful information on the theory and use of galvanometers in general and for complete specifications on the superior 7-300 series, let us send you a copy of Bulletin CEC-1542-X1.

With bodies machined from solid stock and pole pieces brazed into place under hydrogen atmosphere, CEC's new 7-300 series galvanometers provide extreme ruggedness and dust free closure.

Consolidated Engineering CORPORATION

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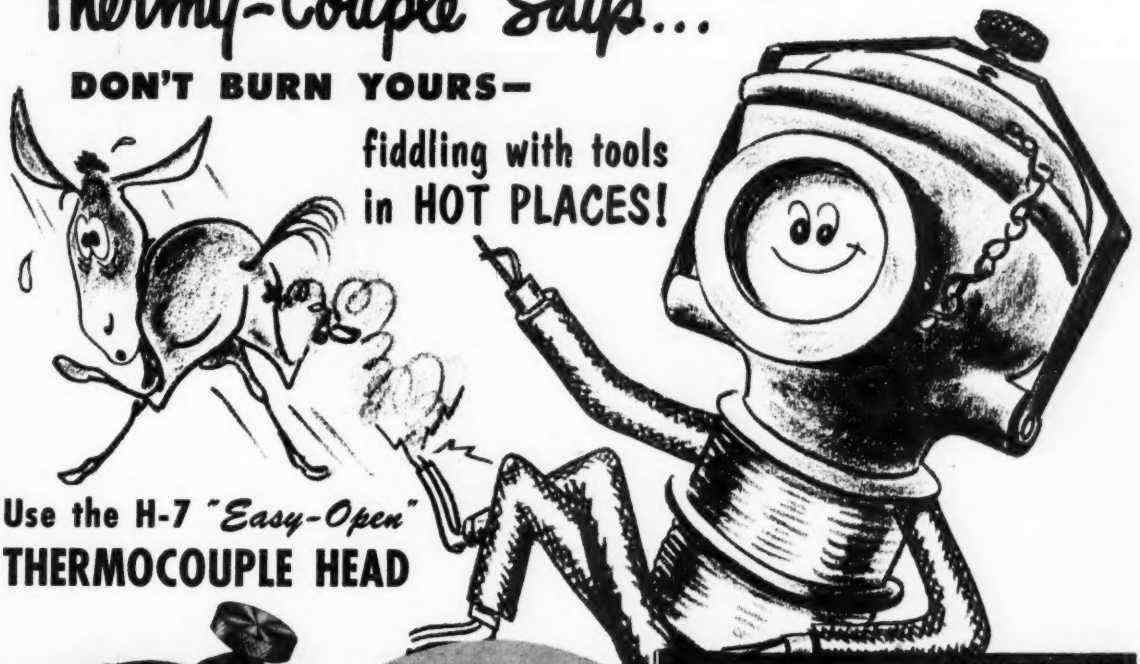

Use the H-7 "Easy-Open" THERMOCOUPLE HEAD

The H-7 is an all-purpose thermocouple head that will accommodate *any size* wire whether base metal or platinum. It fits all standard protection tubes with threaded fittings, metal or porcelain.

Available in 1", ¾" or ½" standard pipe thread thermocouple openings. ¾" conduit lead wire opening.

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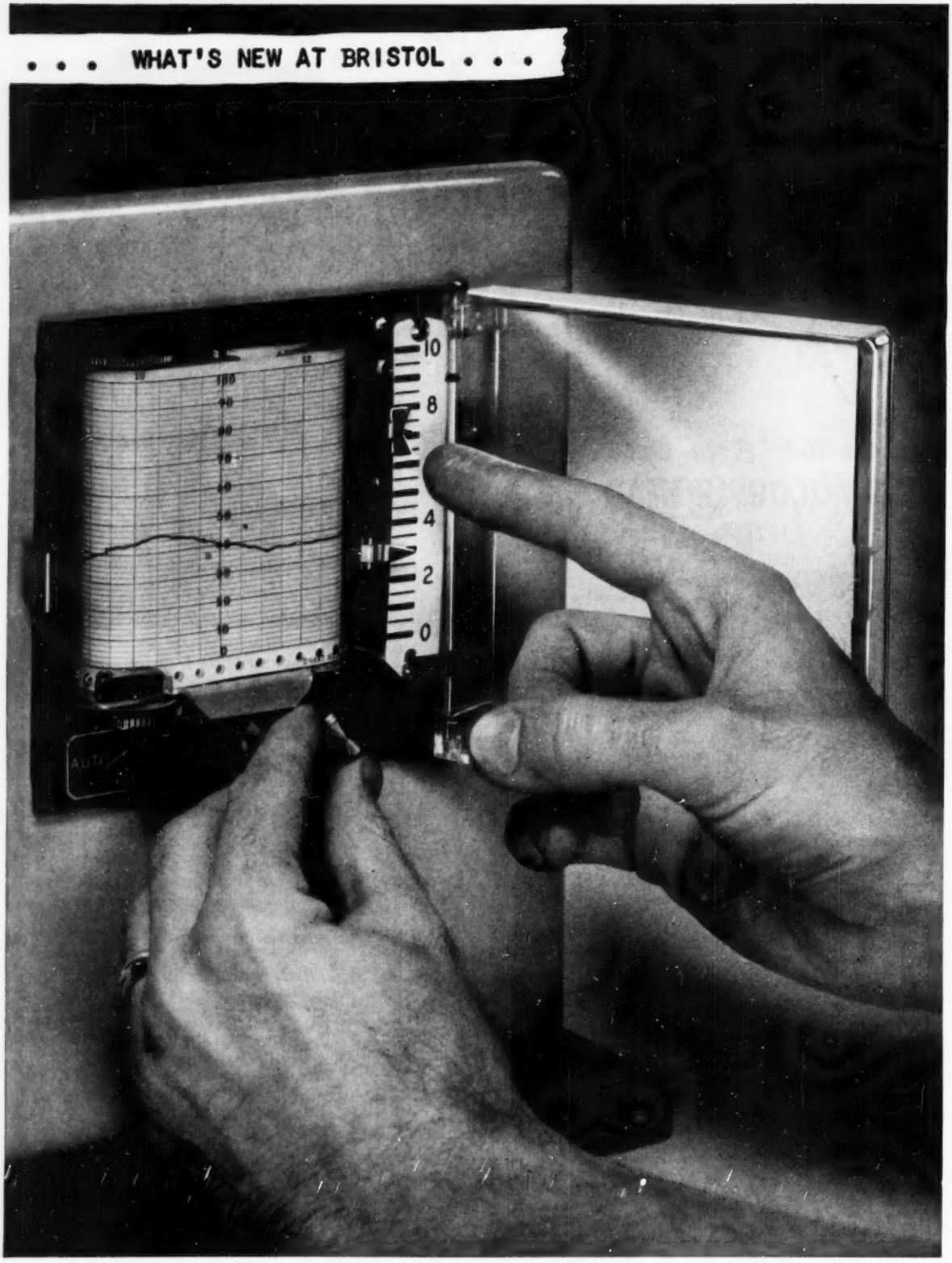


BRISTOL'S "HUMAN-ENGINEERED" METAGRAPHIC RECORDER, with its easy-to-read scale, high-visibility fluorescent pointers and shadow-proof door has earned a reputation as the "biggest miniature in the industry". There's no switching necessary to get a reading of the control valve position. The continuous valve-position indication, separate from set-point indication, gives continuous data on control valve position and process level. The high-precision, two-stage, no-drift set-point regulator has high-capacity (3 scfm) output for fast manual control in emergencies.

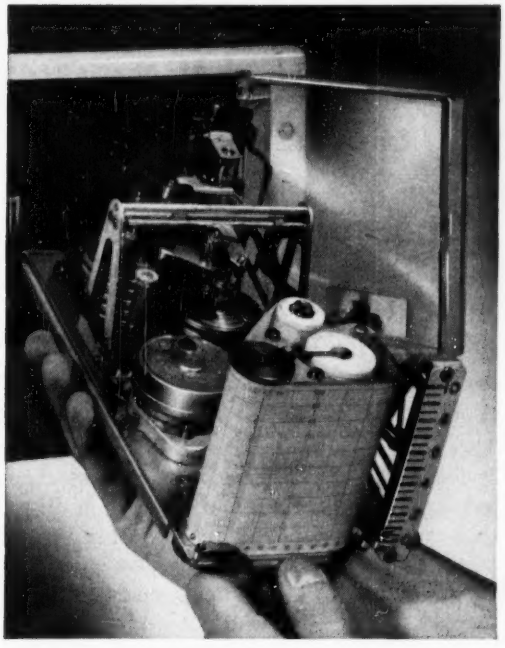
For more information circle **8** on inquiry card.

Instrument men call Bristol's METAGRAPHIC Recorder

"... the biggest little instrument in the industry"

Sounds contradictory, but it's true. Take a look at one of our new METAGRAPHICS mounted on a panel board alongside of other instruments. The Bristol unit stands out – seems bigger than the rest – although chances are it's actually smaller (5" x 5½"). The answer is that the Bristol instruments have been *"human-engineered"*, making them easy to read, and clearly visible at greater distances.

To meet the increasing need for miniature instruments, we didn't simply scale down one of our larger recorders, we designed a completely new unit, creating a smaller instrument with all the advantages of the large one. In other words, the new METAGRAPHIC is a "big" little recorder.



TRUE PLUG-IN SERVICE is a big advantage to the operating man. If trouble is suspected in an instrument, the doubtful unit can be removed and a spare plugged in in a matter of seconds, with no interruption in the process operation, no loss of air, no loss of control.

"Human-engineered" METAGRAPHIC records pressure, temperature, vacuum, flow, differential pressure, and liquid level

Here are some of the advantages of the air-operated Metagraphic Recorders:

SIMPLICITY . . . fewer moving parts, fewer adjustments, and less service required. Range changes can be made in seconds.

CONTINUOUS VALVE-POSITION INDICATION . . . on same instrument scale as set-point scale, gives continuous data on control valve position – makes "bumpless" transfer possible simply by matching pointer positions – no need to read actual scale values – minimizes reading errors – speeds operations.

TRUE PLUG-IN SERVICE . . . provides great savings in installation costs. Cases can be ordered and installed before selecting range and type of control. Instruments can be plugged in later or interchanged at will. This adds up to a big advantage to the process design engineer – he doesn't need to make decisions during the design stage that can't be easily changed later.

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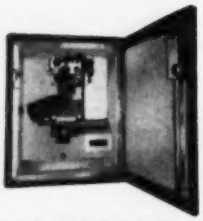

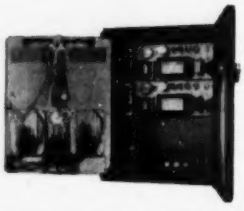

ANALYZER	RECORDER
Highly sensitive to changes in oxygen content.	Self-balancing bridge circuit assures accurate, permanent calibration.
Rapid response to changes in oxygen content.	Electronic amplifier has no moving parts. High sensitivity. Rugged.
No liquid or gaseous fuel required to be added to gas sample.	Immediate response—analyzer is continuously connected to recording pen drive motor.
No chemicals required.	As many as four analyses can be recorded on the same chart.
High accuracy maintained.	Range can be changed easily in the field.
Not affected by wide variation in rate of flow of gas sample.	Isolating transformer for each amplifier removes line interference from bridge circuit.
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Easily installed — no special fittings required.	

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Michigan City 8, Indiana

For more information circle 9 on inquiry card.

NEW!

Q STANDARD

TYPE 513-A

Q measurements to ±3%

Here, for the first time, is a Q-Standard which provides an accurately known Q and reactance for precise measurements. It also provides a convenient way to check overall Q-Meter performance.

This Q-Standard consists of a specially developed winding of Litz wire on a low loss, stable, steatite coil form which is mounted in a hermetically sealed copper shield can filled with dry helium; individual calibration data appears on a decal. A convenient wooden carrying and storage case is included with each unit.

Each inductor is calibrated in terms of effective Q (Q_e); nominal circuit Q (Q_i) readings for the Types 160-A and 260-A Q-Meters are also provided.

Due to the construction of the unit, humidity has negligible effect on the electrical characteristics. Temperature correction data for Q_e is furnished; L and Cd have negligible temperature coefficients.

- **Hermetically sealed against humidity effects.**
- **Inductance accurate to ±1%.**
- **Temperature coefficient data furnished.**

SPECIFICATIONS:

INDUCTANCE (L)

Nominal Value: 250 μh Accuracy: ±1%.

DISTRIBUTED CAPACITANCE (Cd)

(When mounted on Type 160-A or 260-A Q-Meter).

Nominal Value: 9.0 μμf. Accuracy: ±2%.

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(Specified at 0.5, 1.0, and 1.5 mc. and 22°C).

Nominal Value: 180 to 250

Accuracy: ±3%.

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When there's one *best* miniature relay for a given job, be sure you get it! Select the proper Automatic Electric relay and get peak performance, lower costs.

Painstaking workmanship, rigid quality controls and advanced design features have produced a wide range of performance...fast...sensitive...rugged...with a dependability that meets the stresses and strains of the world's toughest applications. The great demand for these relays makes careful planning worth your while to assure required delivery of the particular relays you need!

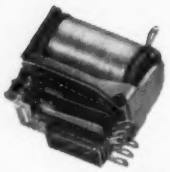
Complete facts and figures on Automatic Electric's Relay line are yours upon request—ask for Circular 1702. Write Automatic Electric Sales Corporation, 1033 W. Van Buren St., Chicago 7, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

RELAYS SWITCHES

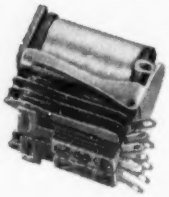
PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

AUTOMATIC ELECTRIC

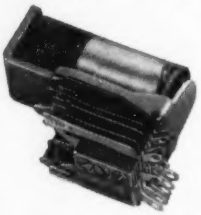
CHICAGO



WHEN SIZE AND WEIGHT ARE LIMITING FACTORS...
Choose this smallest of all Automatic Electric miniature relays. Capacity: 6 contact springs. Weight: 1¼ oz. Dimensions: 1 11/32" x 1 5/16" x 1 1/16". *Specify: Series SQA Relay.*



WHEN GREATER CONTACT SPRING CAPACITY IS REQUIRED...
Choose this double pile-up relay—larger spring capacity in miniature. Capacity: 12 contact springs (up to 18 in some cases, depending upon operating requirements). Weight: 1½-2 ozs. Dims.: 1 11/32" x 1 5/8" x 1". *Specify: Series SQD Relay.*



WHEN ADDITIONAL COIL VOLUME IS IMPORTANT...
Choose this relay which accommodates a slug or sleeve for longer release and/or operate time; a second winding for holding, knock down, or separate operation; or greater winding volume for increased sensitivity or greater heat dissipating ability. Capacity: 12-18 contact springs. Weight: 2-4 oz. Dimensions: 2 1/8" x 1 5/8" x 1". *Specify: Series SLQ Relay.*

FOR EXTRA SENSITIVITY
The "sensitivity" of a Class "S" Relay can be doubled through the use of oversized coils (¼" larger diameter than standard coils). For example: under favorable conditions, standard size coils permit operation of 1 Form "C" spring combination at 4 milliamperes, 24 volts dc; similarly oversized coils permit operation at 2 milliamperes, or less.

HERMETICALLY SEALED—SPECIAL MOUNTINGS
Class "S" Relays are available with or without plug mountings. A wide variety of hermetically sealed enclosures are offered for protection of single or multiple relays.

For more information circle 11 on inquiry card.

Events...

March 22-25
Institute of Radio Engineers Conference and Exhibit, Kingsbridge Armory, New York, N. Y. For information contact W. Copp, 1475 Broadway, New York, N. Y.

March 25-26
Third Conference "Instrumentation for the Iron & Steel Industry" sponsored by the Pittsburgh Section, Instrument Society of America. For information write Dr. A. Peterson, Mellon Institute, Pittsburgh, Pa.

April 6
Sixth Annual Symposium, New Jersey Section, Instrument Society of America, Essex House Hotel, N. J. Subject: Flow and its Measurement. For information write Robert Quick, 17 Lee Drive, West Caldwell, N. J.

April 6-9
Conference on Physics of Particle Size Analysis, sponsored by the Institute of Physics, Nottingham, England. For information write Institute of Physics, 47 Belgrave Square, London, S. W. 1, England.

April 14-16
Society for Experimental Stress Analysis Spring Meeting, Educational Lecture & Exhibit, Netherlands Plaza Hotel, Cincinnati, Ohio. For information write Harry LaTour, 134 Kensington Street, Middletown, Ohio.

April 19-20
Symposium on the Automatic Production of Electronic Equipment sponsored by Stanford Research Institute and U. S. Air Force, Fairmont Hotel, San Francisco, Calif. For information write L. K. Lee, Advanced Technique Group, Stanford Research Inst., Palo Alto, Calif.

April 19-23
Sixteenth session of the semi-annual X-ray Diffraction School at the plant of North American Philips. For information write Vern W. Palen, c/o North American Philips Co., Inc., 750 South Fulton Ave., Mount Vernon, N. Y.

April 21-23
Second Annual Conference on Feedback Control Systems, sponsored by American Institute of Electrical Engineers, Hotel Claridge, Atlantic City, N. J. For information write G. L. Stancliff, Jr., Vickers, Inc., 723—15th St., N. W., Washington, D. C.

April 22
Conference on Instrumentation in Water, Sewage and Industrial Waste Treatment, Manhattan College, New York City. For information write Brother Joseph McCabe, Civil Engineering Dept., Manhattan College, New York 71, N. Y.

April 22-29
American Institute of Electrical Engineers, Electronic Components Conference, Washington, D. C. For information write R. S. Gardner, A.I.E.E., 29 West 39th St., New York, N. Y.

April 28-30
Second Annual meeting of ASTM Committee E-14 on Mass Spectrometry, Jung Hotel, New Orleans, Louisiana. For information write J. G. Hutton, General Electric Co., Schenectady, New York.

May 5-7
Third International Aviation Trade Show, 71st Regiment Armory, New York. For information write Eugene P. Connelly, Aircraft Trade Shows, Inc., Hotel McAlpin, New York 1, N. Y.

Sept. 13-25
Instrument Society of America First International Instrument Congress and Exposition, Commercial Museum and Convention Hall, Phila. Contact Richard Rimbach, Mgr., 845 Ridge Ave., Pittsburgh 12, Pa.

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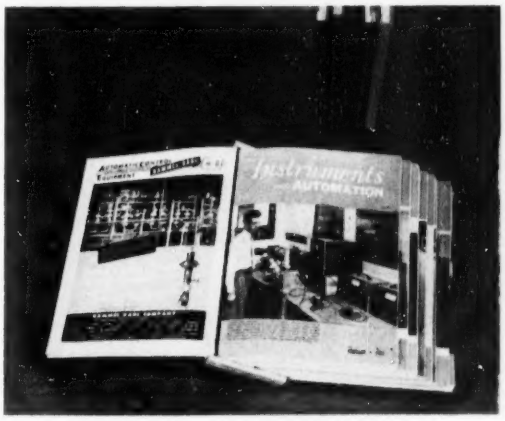

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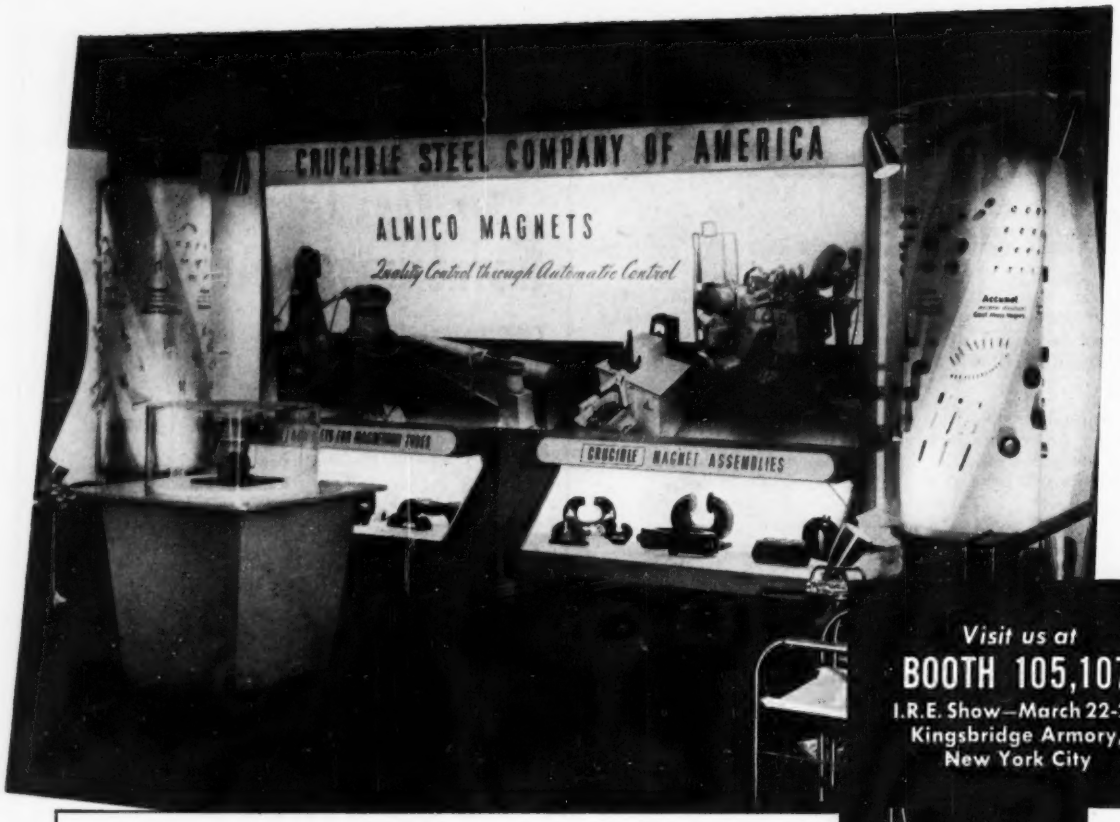

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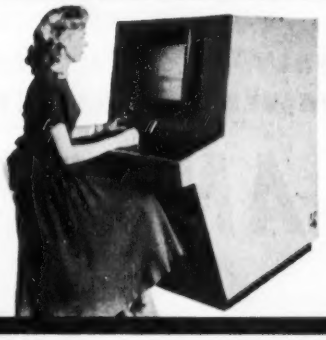

For more information circle **14** on inquiry card.

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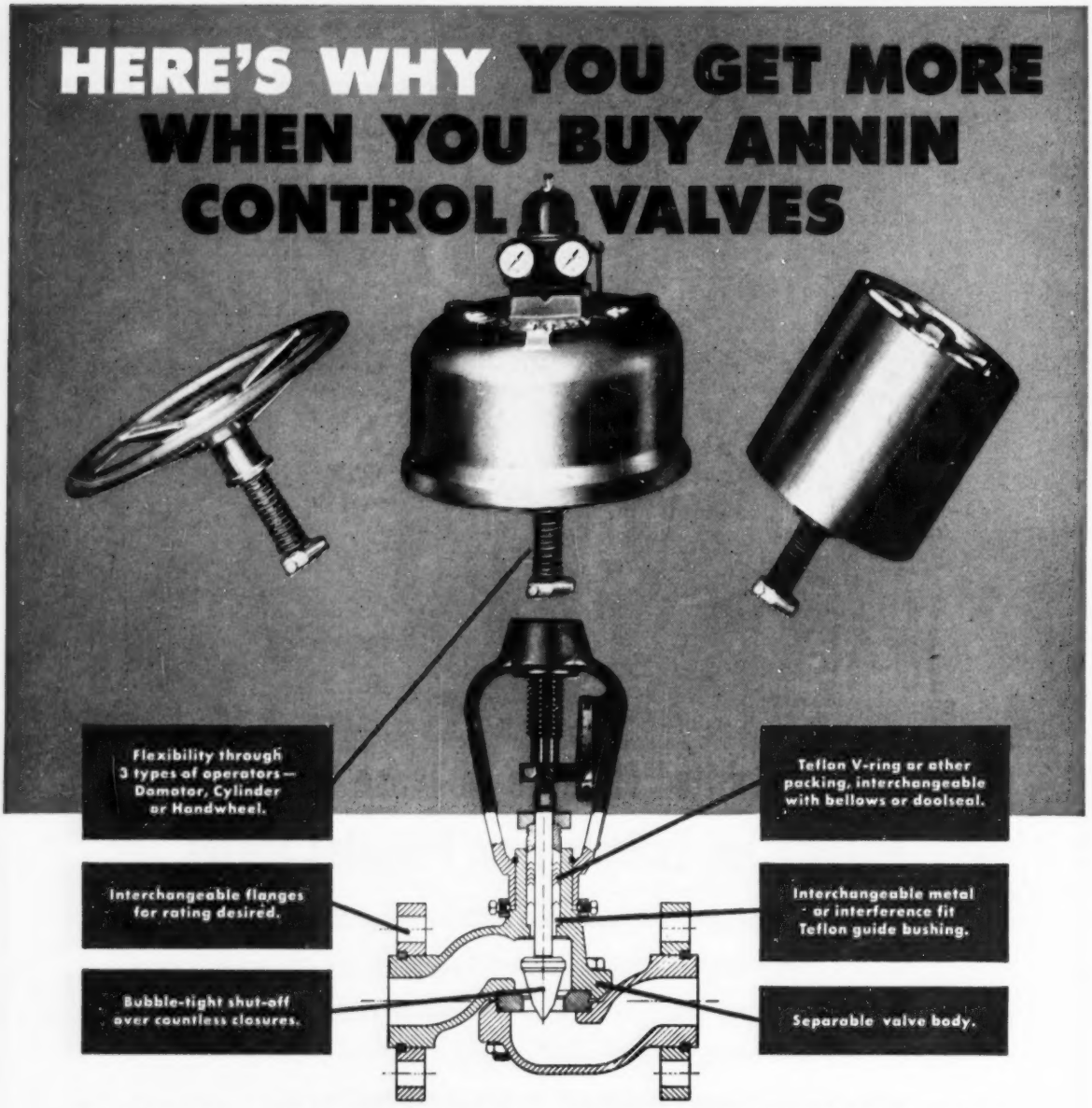
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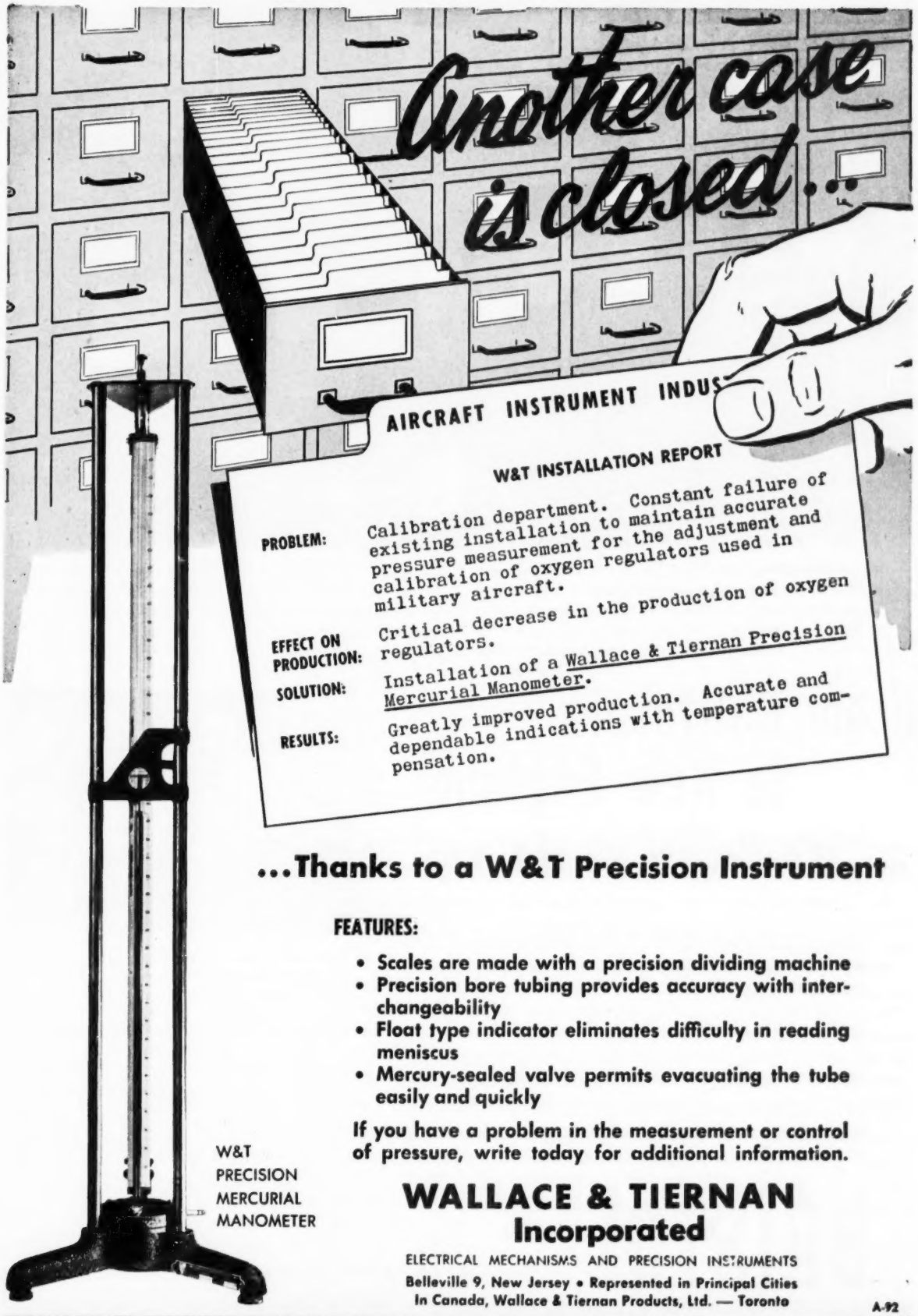
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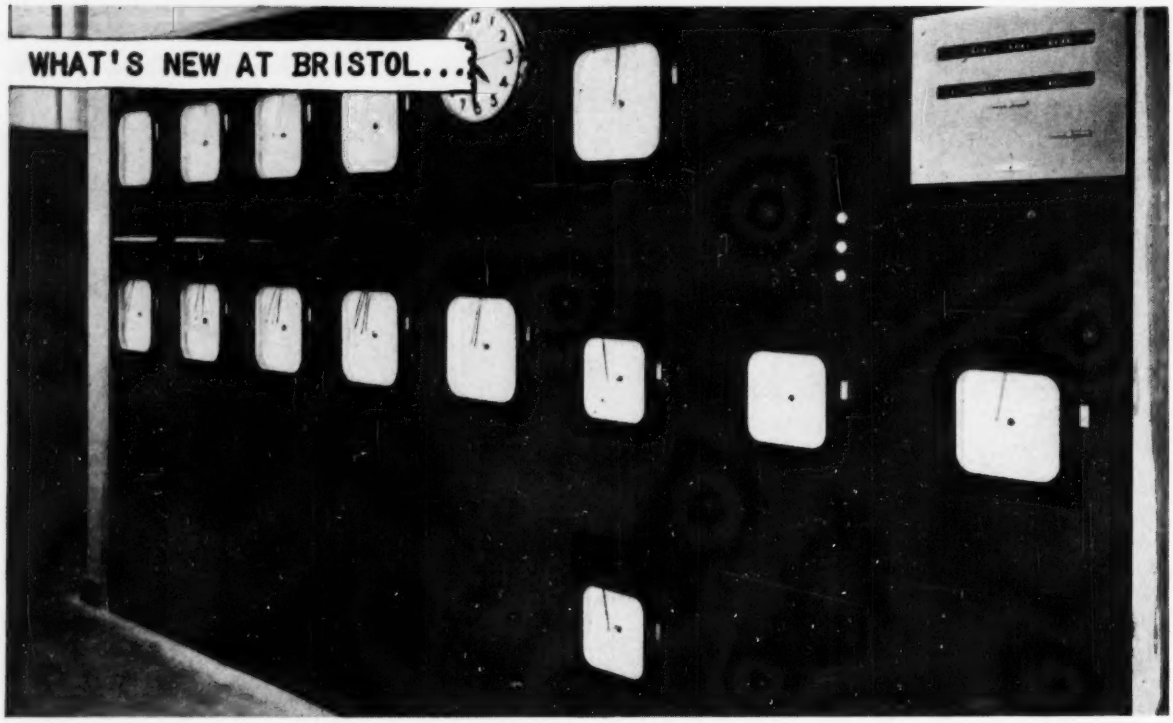

IN SAN FRANCISCO. Control panel at the new Point Richmond Holder Station of the Pacific Gas and Electric Co. The Bristol Metameter Receivers on this panel record readings of flow and pressure at focal points of load in the natural gas distribution and transmission systems for San Francisco Bay section. This installation is part of an elaborate system of Metameter Telemetering and remote control, involving distances up to 50 miles, used on this company's far flung network of pipe lines throughout northern and central California. This company is using Metameters that have been in operation since 1935.

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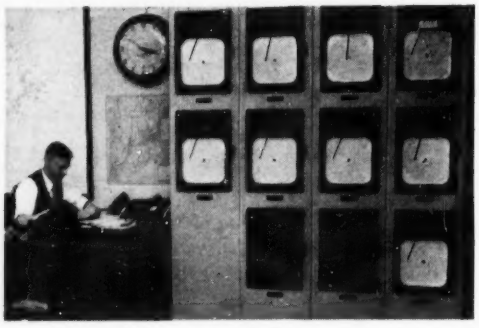

IN SPRINGFIELD, MASS. Dispatching Office of Northeastern Gas Transmission Co., in Springfield, Mass. Pressure readings from six New England points are received by the two Time-Multiplex Receivers shown on the bottom of the panel and individually recorded by the 9 Metameter Receivers. With the new Bristol Multiplexing equipment, up to 15 readings can be transmitted over a single circuit. Thus, tremendous savings are made in circuit costs. .3.34

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Trends...

Late News and Comments

Magnetic tape is key component in new and expanding fields of data handling, digital and analog computing, and machine-tool automation. For machine-tool automation, motions are translated into electric signals by self-synchronous motors and recorded on tape which can duplicate process indefinitely. Second new field now opening is magnetic-tape recording of TV video signals; a 15-minute program requires 4 to 6 miles of tape.

New techniques for transient recording (see pages 464-466 of this issue) make possible rapid and economic transfer of tape-recorded signals to conventional oscillographic and direct-writing recorders. Tape industry—including tape and tape handling—should expand rapidly.

Use of electronic equipment by industry is expanding by nearly 20% per year. Frank W. Mansfield, Director of Sales Research of Sylvania Electric states: "Most of the development work for applications of electronic equipment to industry and commerce lies ahead, but some day sales in this field will compare favorably with those of equipment for entertainment and defense. . . . Equipment for industry and commerce will total about $274,000,000 in 1954, and by 1957-59 will be at an annual rate of $520,000,000 and by 1960-62 at a rate of $945,000,000."

Atomic energy spending by USAEC for fiscal 1955, which starts July 1, will increase to $2,425,000,000—compared with $2,200,000 in the current fiscal year.

Radioisotopes from AEC reactors were requested by more than 1800 institutions in 1953—an increase of 30%. Largest single category of users was—industry.

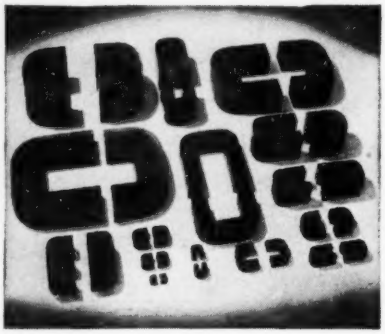
Among firms operating the nuclear program for the Atomic Energy Commission, the largest private USAEC contractor is now—General Electric Company. GE activities include Knolls Atomic Power Lab (submarine reactor), Aircraft Nuclear Propulsion Lab at Evandale, Ohio, Hanford Atomic Products Operation at Richland, Wash., (plutonium production).

Post-war shortage of fundamental aerodynamic knowledge, resulting partly from World War II blackout of information, now is being combatted by expanded wind-tunnel program. World's largest wind-tunnel facility (called Propulsion Wind Tunnel) is now under construction at Tullahoma, Tenn. by Air Force; 216,000-hp. drive will develop air speeds from Mach 0.8 to Mach 3.5.

World's highest ratio of industrial productivity per man hour of human labor is direct result of use of automatic control by American industry—not because of "secret" manufacturing techniques, as mistakenly assumed by other nations. America's real secret, which we offer to all other nations is: First develop wide customer interest and large market by promotional techniques—then produce in vast quantity, at low unit cost, by extensive use of automatic control. This is the "secret" of the American standard of living.

ARNOLD MAGNETIC MATERIALS

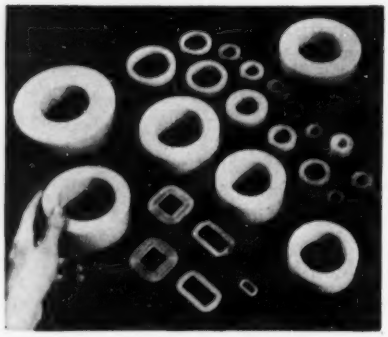
TYPES "C" AND "E" CUT CORES



Arnold "C" and "E" Cores are made from precision rolled Silectron strip (highly oriented silicon steel) in 1, 2, 4 or 12-mil thicknesses and a wide variety of window sizes and core areas, for high and low-frequency applications. Sizes range up to 10 lbs. in 12-mil strip, and from fractions of an ounce to hundreds of pounds in the thinner gauges. Cores wound from ultra-thin strip (down to ¼ mil or less) can also be supplied.

Insulated strip of the proper width is wound on a mandrel, then heat treated, bonded and cut into halves. Careful control results in accurately dimensioned and matched core halves whose effective air gap at the butt joint is very small.

In 3-phase applications, the use of "E" Cores provides weight and size reduction, as well as higher efficiency and possible cost savings. Rigid standard tests are employed for both "C" and "E" types of cores, and special tests where required.



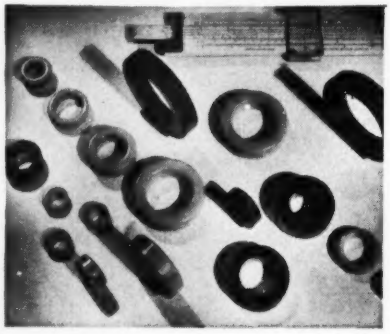
TAPE WOUND CORES

Depending upon the specific properties required, Arnold Tape Wound Cores are available made of Deltamax, 4-79 Mo-Permalloy, Supermalloy, Mumetal, 4750 Electrical Metal, or Silectron . . . in standard tape thicknesses of 1, 2, 4 or 12-mils, and in ultra-thin gauges of ½ and ¼-mil where required.

Practically any size core can be supplied, from a fraction of a gram to hundreds of pounds. Toroidal cores are made in 22 standard sizes with protective nylon cases. Special sizes of toroidal cores, and all square or rectangular Tape Wound Cores, are manufactured to meet individual requirements.

Used for magnetic amplifiers, pulse transformers, current transformers, wide-band transformers, non-linear retard coils, peaking strips, reactors, etc., this gapless type of core construction results in maximum effective working permeability with minimum flux leakage.

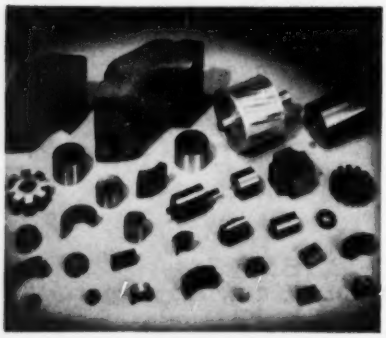
MOLY-PERMALLOY POWDER CORES



For use in loading coils, filters, broadband carrier systems and networks, for frequencies up to 200 kc, these Toroids provide high Q in a small volume, and are characterized by low eddy current and hysteresis losses.

Arnold Powder Cores are supplied in four standard permeabilities: 125, 60, 26 and 14 Mu. They provide constant permeability over a wide range of flux density. The 125 Mu cores are recommended for use up to 15 kc; the 60 Mu at 10 to 50 kc; the 26 Mu at 30 to 75 kc; and the 14 Mu at 50 to 200 kc. Many of these cores may be furnished stabilized to provide constant permeability (±0.1%) over a specific temperature range.

These Moly Permalloy Powder Toroids are available in a wide range of sizes, to obtain nominal inductances as high as 281 mh/1000 turns. They are given various types of enamel and varnish finishes, some of which permit winding with heavy Formex insulated wire without supplementary insulation over the core.



ALNICO MAGNETS

Arnold manufactures permanent magnets from all grades of Alnico, although Alnico V is usually the preferred type due to the high value of energy product of that alloy. Alnico Magnets are quite hard and somewhat brittle and may be machined only by grinding. Most sizes and shapes are manufactured as sand castings and are made to the customer's drawings and specifications. Some types and shapes of Alnico Magnets are carried as stock items.

Some small sizes of magnets may be furnished in sintered Alnico, but special shapes made in this way require rather expensive dies.

Stock sizes of all the products above are listed in Catalog GC-106. Write for your copy . . . but if you're attending the IRE show this year, see us at Booth 148.

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INSTRUMENTS ON THE MARCH

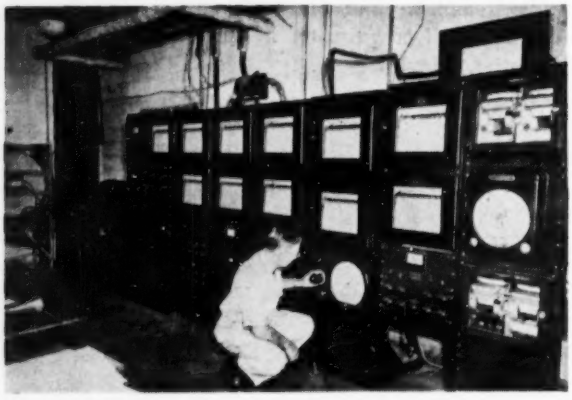
New Principles, Applications, Non-commercial Developments

High-temperature Transistors

WALTHAM, MASS.—Successful development of experimental silicon junction transistors is announced by N. B. Nichols, manager of Raytheon Manufacturing Company's research division. He said that these transistors have been tested at temperatures up to 350 degrees Fahrenheit. This may overcome a limitation that has restricted many applications of germanium transistors.

New Rocket Research Lab

LAFAYETTE, IND.—Completion of a $100,000 rocket research laboratory, the latest addition to extensive rocket and jet-propulsion research facilities built on the campus of Purdue University, was announced by officials of the university.



Dr. M. J. Zucrow, director of the Purdue University Rocket Laboratory, calibrates a pressure gage prior to test run. This battery of recording instruments developed by Honeywell provides the researchers with permanent records of the rocket motor's behavior.

New University Reactor

WASHINGTON, D. C.—The U.S. Atomic Energy Commission has approved the allocation of fissionable material as fuel for a nuclear reactor to be built by Pennsylvania State University.

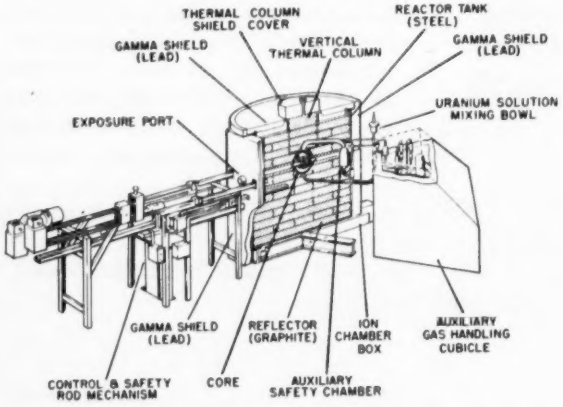
The low-power "swimming-pool" reactor will be operated for nuclear research and for the training of students. It is the second privately owned reactor for which the AEC has authorized the use of nuclear fuel. The first, built by the Consolidated University of North Carolina, began operation last September 5.

The Pennsylvania State University reactor will be constructed and housed on the university campus for an estimated $250,000 to $300,000. The cost of construction and operation will be borne by the university, without financial assistance from the AEC. The reactor will operate at a power level of 100 kilowatts. It will be cooled and moderated with ordinary water, and will use enriched-uranium fuel. The fuel elements will be suspended in a pool of water sufficiently deep to serve as a shield against the radiation produced by the reactor.

Water-boiler Reactor

DOWNEY, CALIF.—A powerful self-contained "percolating tea kettle" atomic-energy reactor for special nuclear research has been designed and built by North American Aviation for the Atomic Energy Commission. The reactor now is in operation by the California Research and Development Company, Livermore, California.

Developing 100 watts of power, the reactor is the largest unit of its type to operate with a closed cycle, or "self-



contained" system. The "tea kettle" or water-boiler-type reactor, one in which the fissionable uranium compound is contained in a water solution, is designed so all radioactive by-products of the fission process are retained in the unit instead of being exhausted and mixed with the open air, as in other large reactors of this type. Radioactive by-products in the North American reactor are processed inside the unit and returned to the reactor core. It is possible for the reactor to run for as long as 10 years without refueling.

Control rods, left, regulate the fission process in the one-foot sphere or core, center, where four gallons of uranyl sulfate are contained. Unique feature of the reactor is that it emits no exhaust or fumes as with other large reactors of this type.

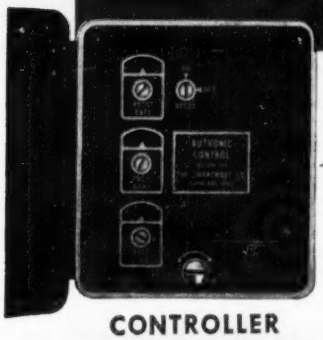
Ultrasonic Testing

WASHINGTON, D. C.—Reed Research, Inc., of Washington has recently developed an ultrasonic technique for nondestructive testing of certain non-metallic solids. The work was sponsored by the Navy Bureau of Ordnance. The equipment uses ultrasonic absorption techniques and automatic scanning to produce high contrast records of simulated flaws or mechanical defects which were imperceptible in X-ray photographs of the same sample.

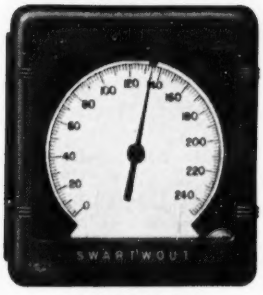
A pair of barium titanate transducers are arranged to transmit and receive acoustic energy (continuous-wave transmission at 383 kilocycles/second) along radii of the

ANNOUNCING...

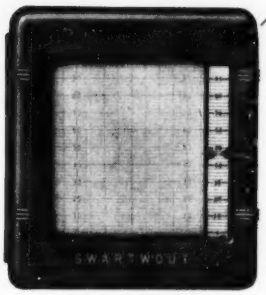
THERMOCOUPLE CONVERTER



CONTROLLER



INDICATOR



RECORDER

Exhibited for the first time at the recent Chicago Instrument Show, the Swartwout Autronic Thermocouple Converter is now in production. Designed primarily for use with components of the Autronic system, it is a high impedance all-electronic null-balance unit which does not draw current from the thermocouple. D-c millivolt signals are converted to 0.000-0.500 volt a-c. Range is easily and quickly converted by changing range cards. There are no pilot valves, flappers or other troublesome parts. Operation is instantaneous, maintenance virtually eliminated.

CONDENSED SPECIFICATION DATA

SPAN: 2 to 50 millivolts
ZERO SUPPRESSION: −10 to +50 millivolts
SPAN ACCURACY: ½%
SUPPRESSION ACCURACY: 0.1%
REPRODUCIBILITY: ¼%
SENSITIVITY: 0.1%
REFERENCE JUNCTION COMPENSATION: Automatic—Removable card for different thermocouple materials
SPAN AND ZERO ADJUSTMENT: Replaceable range card
REFERENCE VOLTAGE: Standard cell
INPUT IMPEDANCE: Null-balance—draws no current
OUTPUT VOLTAGE: 0.000 — 0.500 volts, 60 cycles a-c
CASE: Surface mounting

Other Swartwout a-c and d-c converters are available for use with primary elements such as pH, oxygen, strain gage, electronic flowmeter, cascading, ratioing, etc. Literature and information available on request to Swartwout representatives or to the plant. A-8511

Swartwout *Autronic* CONTROL SYSTEM

THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12 • OHIO

For more information circle **20** on inquiry card.

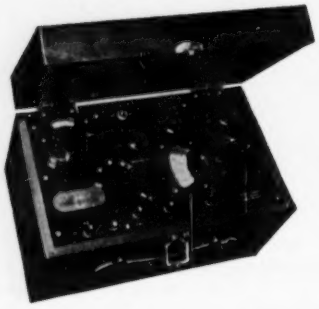
Precise
TEMPERATURE MEASUREMENTS

. . . with the Rubicon
MUELLER BRIDGE

A highly accurate and specialized form of the Wheatstone bridge designed expressly for precise resistance thermometry with three- or four-lead thermometers and for the measurement of other similar resistors within its range.

- Wide range: 0 to 141.1110 ohms in increments of 0.0001 ohm
- Unity ratio with provision for convenient checking and precise adjustment of ratio arms
- Built-in mercury commutator for lead resistance compensation
- Sub-panel switch construction
- Built-in plug and block assembly for conveniently checking ratio, bridge zero and thermometer resistance with no disturbance of external bridge connections

Described in Bulletin 100



. . . with the Rubicon
PORTABLE PRECISION POTENTIOMETER

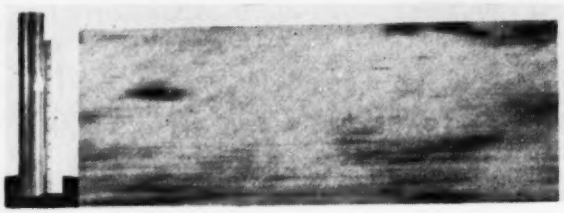
A two-dial instrument of exceptional accuracy and sensitivity.

- High-sensitivity, sturdy, built-in Pointerlite galvanometer—permits balancing to within 2 microvolts in low resistance circuits
- Completely self-contained assembly—no external accessories except the thermocouple circuit
- Two ranges —0 to 16.1 and 0 to 161 millivolts—readable to within 2 and 20 microvolts respectively
- Sturdy, compact construction for long dependable service

Described in Bulletin 270

RUBICON COMPANY
Electrical Instrument Makers
3755 Ridge Avenue Philadelphia 32, Pa.
For more information circle **21** on inquiry card.

ON THE MARCH—CONTINUED



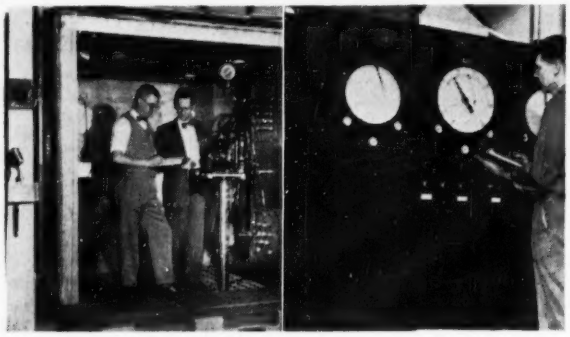
cylindrical test sample, which is revolved about its longitudinal axis at 100 rpm. The transducers simultaneously traverse the length of the cylinder at a rate of approximately 0.1 inch per revolution of the cylinder, producing a helical scan the full length of the sample. This entire assembly is submersed in water for good acoustic coupling. The scanning mechanism is coupled through gears to a cylindrical recording drum having the same angular velocity as the test sample.

The output from the receiver transducer is fed through appropriate electronic circuitry to a tungsten stylus held in contact with electro-sensitive paper (Teledeltos) mounted on the recording drum. As in facsimile recording, the stylus traverses the length of the rotating drum, leaving a trace whose intensity (dot size) corresponds to the level at the receiver.

The resulting record, or "Acoustigraph," may be interpreted in the same manner as a *positive* radiograph which might be obtained by passing an X-ray source along the center perforation of a stationary cylinder wrapped with photographic film. Dark areas in both types of records represent regions of decreased transmission through the material being inspected.

Test Chamber

BELLEVILLE, N. J.—Walter Kidde & Co. of Belleville uses a $125,000 Guardite test chamber for testing their



aircraft equipment. A novel feature is a microphone and speaker arrangement that permits either communication with the interior or audible checks while tests are in progress.

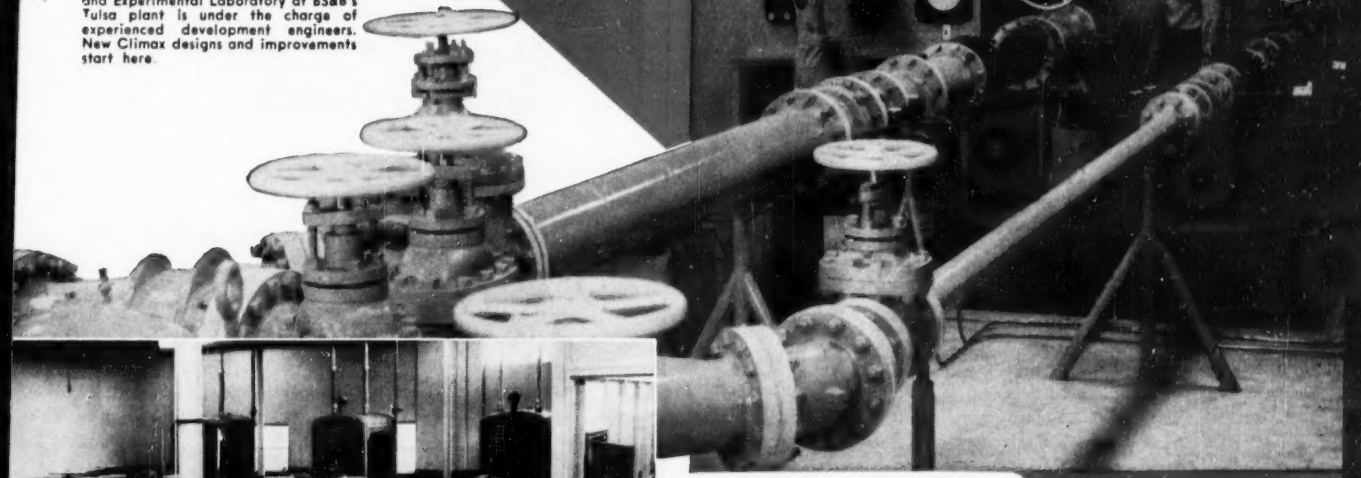
Computer Film

ENDICOTT, N. Y.—"Piercing the Unknown," a new 16-mm. 22-minute color-sound motion picture that may be borrowed free of charge from International Business Machines Corporation, traces the development of computing devices up through the IBM Electronic Data Processing Machines, IBM's latest "giant brain"; also tells how computers can solve problems in design, ballistics, chemistry, physics, and other fields. The film may be booked through

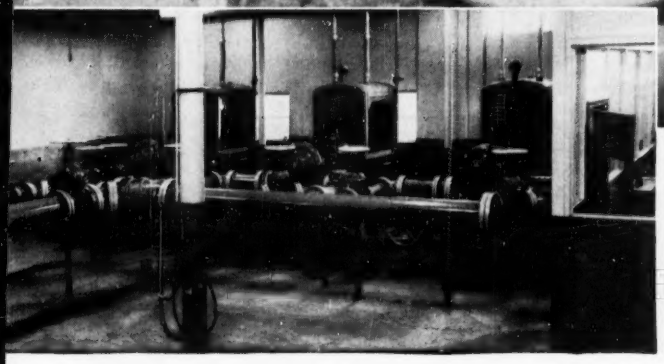
Testing the performance on which BS&B reputation has been built;

Pre-Proving CLIMAX CONTROLS to Insure On-The-Job Efficiency

Experimentation is the first step in final development. This interesting corner of the new Climax Hydraulics and Experimental Laboratory at BS&B's Tulsa plant is under the charge of experienced development engineers. New Climax designs and improvements start here.



The finished control on the "torture rack." Meter runs flow test the valves up through 10". Strain gauge equipment analyzes forces and stress under performance. Control panel in background regulates engines driving the pumps and registers flow data for calculation.



Pump manifolding for the 3 engine-driven pumps which will deliver up to 4500 gallons per minute at a 100 lb. discharge for high volume tests. Pumps can also be manifolded for series operation, in which case 300 lbs. of water at 1500 gallons per minute can be delivered.

There's no question about a Climax Control giving the satisfactory service for which it is designed. That performance is tested and proven before the control goes into the field . . . checked for minimum and maximum capacity. Flow, flow effects, valve characteristics and strain results are all evaluated by experienced engineers. Through the new BS&B Climax Control Hydraulics laboratory come a continuing series of answers to the more efficient, safe and profitable application of automatic controls. One test suggests another, one application is adapted to a similar problem. The net result: Through research, better engineering, and accurate pre-testing, comes a more efficient Climax Control.

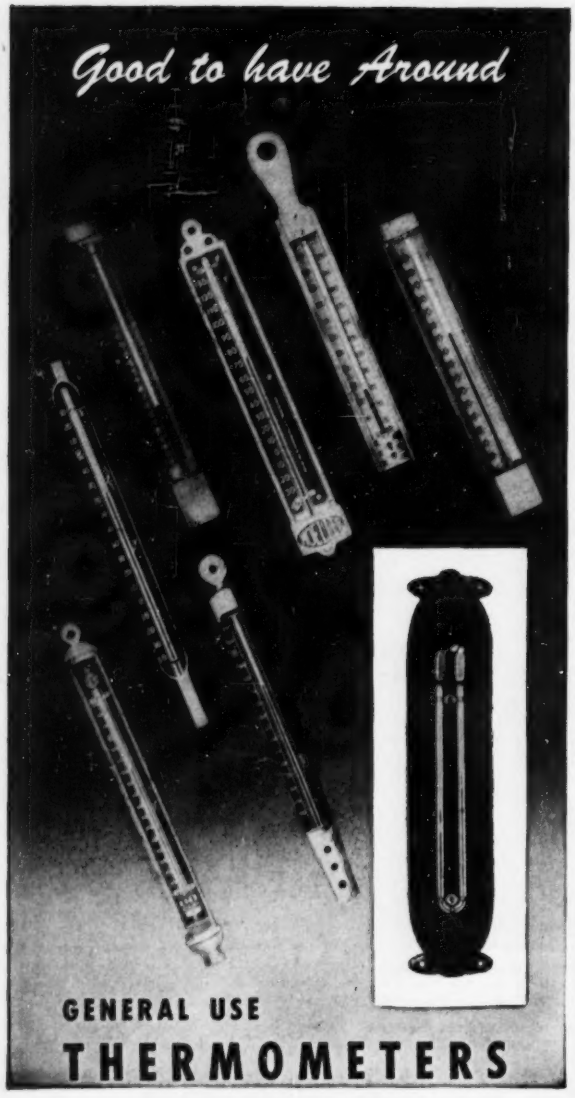
New Climax Controls Hydraulic and Experimental Laboratory

BLACK, SIVALLS & BRYSON, INC.

Climax Controls Division, Dept. 4-V3
7500 East 12th Street • Kansas City 26, Missouri

CLIMAX BS&B CONTROLS OUR 60TH YEAR

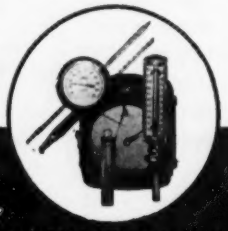
For more information circle **22** on inquiry card.



Dependability that began 84 years ago continues to serve industry with accurate and reliable thermometers.

Then as now, Moeller Thermometers unalterably live up to the high standard of performance required by modern industry.

Send for catalogs and literature on
INDUSTRIAL, LABORATORY
AND RECORDING THERMOMETERS
VACUUM GAUGES • HYGROMETERS
HYDROMETERS • PSYCHROMETERS
AND MARINE SPECIALTIES



MOELLER
INSTRUMENT COMPANY
132nd ST. and 89th AVE. • RICHMOND HILL 18, N. Y.
Representatives in Principal Cities

For more information circle **23** on inquiry card.

ON THE MARCH—CONTINUED

any IBM branch office, or write, stating dates, to the Department of Education, International Business Machines Corp., Endicott, New York.

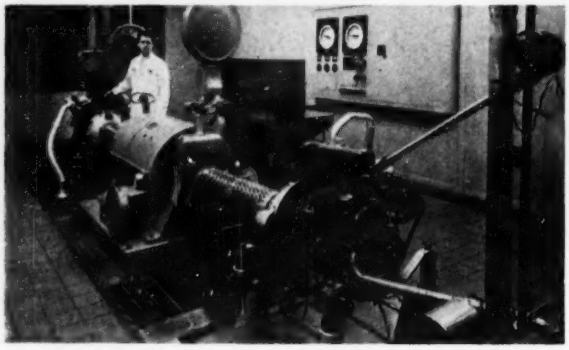
Measurement Mobile

SCHENECTADY, N. Y.—A modern "instruments exhibit on wheels" containing the latest G-E instruments began

a year's tour of the nation November 2 that will take it to all 48 states. Object: to present the latest techniques in industrial instrumentation and to promote "instruments for increased productivity." At its more than 250 stops, instrument schools complete with film presentations will be conducted for industrial customers.

Engine Dynamometer

DEARBORN, MICH.—Electronically-controlled Westinghouse dynamometers provide an indoor highway for automotive testing at the Ford Motor Company's new Research



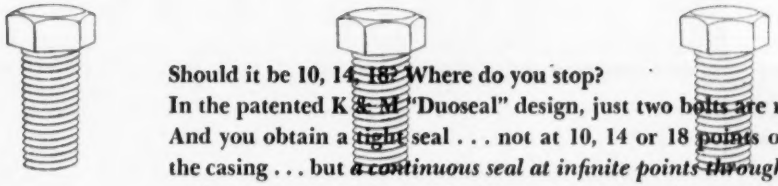
and Development Center, Dearborn, Mich. An operator is shown adjusting one engine on test, while the engine in foreground is being set up for similar tests. Westinghouse dynamometer (in center) is equipped with a double-extended shaft to permit dual mounting. In this test, the speed-torque curve of the engine is obtained; also data on such items as optimum spark setting, carburetor adjustment, and fuel consumption.

Analysis of HF Gas

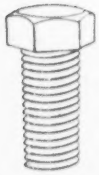
PALO ALTO, CALIF.—A new method of identifying and continuously measuring hydrogen-fluoride gas—a potentially-injurious air pollutant—has been developed at Stanford Research Institute. The new device can detect and measure parts-per-billion of HF gas in the atmosphere.

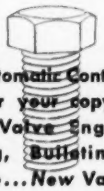
Detection is made on a roll of filter paper impregnated

How many bolts are required for a perfect seal?

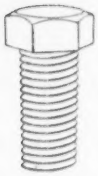


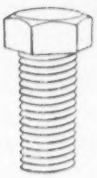
Should it be 10, 14, 18? Where do you stop?
In the patented K & M "Duoseal" design, just two bolts are required. And you obtain a tight seal . . . not at 10, 14 or 18 points on the casing . . . but *a continuous seal at infinite points throughout the entire perimeter.* The result: A completely tight, leakproof seal that actually grows tighter as control pressure increases.
Furthermore, K & M "Duoseal" saves maintenance time with only two bolts to tighten. This time saving is a particular consideration when valves *must* be serviced or inspected in the line.
Within the drawn steel diaphragm casing, the K & M molded neoprene diaphragm provides an extremely large effective area that is constant throughout the long stem travel. Virtually the highest "power factor" available results, with more sensitive response to control pressure variations, more accurate inner valve positioning and improved flow regulation through the K & M valve body.





***For Complete** Automatic Control Valve Data: Write for your copy of the new K & M Valve Engineering Data Catalog, Bulletin CV53. **Also, Available...** New Valve Size Calculator with Low Flow Data.*





diaphragm control valves

KIELEY & MUELLER, INC.

K&M

Valve Makers
Since 1879

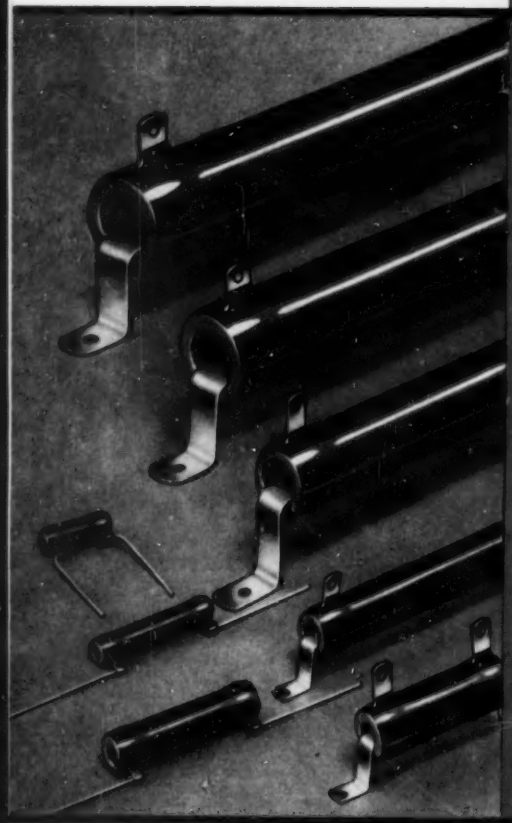
64 Genung Street
Middletown, New York

For more information circle **24** on inquiry card.

Now in All Sizes . . .

Welded Terminals

ON OHMITE® RESISTORS



PATENTED OHMITE PROCESS ASSURES **PERFECT WELDS**

Ohmite has perfected and patented a new welding technique, and has developed a method of testing every weld between the resistance wire and terminal. Thus, with every Ohmite resistor, you are assured of permanent terminal connections, unaffected by vibration or high temperatures.

PERFECT ELECTRICAL CONNECTIONS

The fusion of the metal in the resistance wire and terminal lug provides a perfect and permanently stable electrical connection. This is extremely important in eliminating noise in audio circuits or instability in other highly sensitive circuits.

HIGH-STRENGTH ALLOY TERMINALS

The terminals on Ohmite resistors are made of a special high-strength alloy, which has a coefficient of expansion that is properly related to that of the enamel, ceramic core, and wire. This keeps the terminal firmly anchored, and prevents cracking of the enamel.

The resistance wire is welded practically flush with the terminal, so there is no projection extending from the surface. Hence, the connection and terminal are as well covered and protected by the vitreous-enamel coating as the winding itself.

PROVED IN TEN YEARS OF SERVICE

Ohmite developed welded terminals more than ten years ago. Since that time, this construction has been gradually extended to cover the entire Ohmite line. Millions of these welded resistors have proved their reliability in the toughest kind of service.

WRITE on Company Letterhead for Catalog and Engineering Manual No. 40.

Plus THESE OTHER OHMITE FEATURES

Ohmite resistors provide other important advantages, too—a superior vitreous-enamel covering, which holds the winding rigidly in place, preventing "hot spots," and protecting the winding from moisture and fumes; strong ceramic core that is unaffected by cold, heat, fumes, or high humidity; and hot tinned terminal lugs for ease in soldering. For unfailing dependability, specify Ohmite resistors.

OHMITE MANUFACTURING CO.
3615 Howard Street, Skokie, Illinois (Suburb of Chicago)

Be Right with

OHMITE®

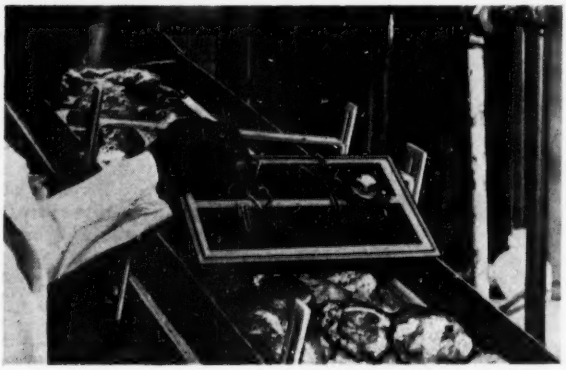
RHEOSTATS • RESISTORS • TAP SWITCHES

For more information circle **25** on inquiry card.

with a fluorescent metal salt. Contact with the slightest trace of HF gas diminishes the fluorescence, which is measured photoelectrically. Results are graphed on a continuous recorder.

Magnetic Separation

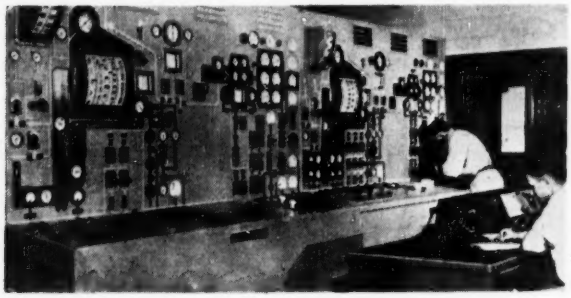
PHILADELPHIA, PA.—Sharpe & Dohme, Inc., of Philadelphia, employ Eriez magnetic separation equipment in the manufacture of insulin. Extraction of insulin starts with



the grinding of beef pancreas glands. To prevent tramp iron from getting into the pancreas grinder, two Eriez plate-type magnetic separators are suspended over the conveyor line. The Alnico V magnets remove this ferrous contamination. The plate-type magnets are produced by Eriez Mfg. Co., Erie, Pa.

117,000-kw. Station

WICHITA, KANS.—A new generating station with a total load capacity of 117,000 kilowatts has been put into operation by the Kansas Gas and Electric Company, Wichita. A compactly designed control panel, designed by



Ebasco, facilitates regulation of the operation of the new station. Incorporating miniaturized recording instruments, especially developed by Minneapolis-Honeywell's Industrial Division, the panel monitors critical operating conditions—turbine steam pressures and temperatures, boiler excess air, and condenser vacuum. The eight-foot-long graphic panel is believed to be the first to utilize miniature instruments in an electric power generation application.

Systems Engineering

PHILA., PA.—A new course in systems engineering has been opened at the University of Pennsylvania's Moore School of Electrical Engineering. Developed and established by educators at the university, working with management and engineering officials of the Radio Corporation of America, the course will provide advanced post-graduate

Guard your instruments

against moisture, dirt and oil!

Make sure that your air-operated instruments get the *best* in filtration equipment. Use MICRO-KLEAN, the modern micronic filter, to keep moisture, dirt and oil from harming your instruments and affecting their accuracy. MICRO-KLEAN's double-capacity cartridge gives twice the effective cartridge life—and of course that cuts replacement costs in half.

You have a big investment in your instruments—be certain that your investment is protected. Let Cuno's filtration engineers help you get the most out of your instruments in terms of accuracy and long life. Write for free copy of our MICRO-KLEAN Air Line Filter Bulletin. Cuno Engineering Corporation, Dept. 387 M South Vine Street, Meriden, Connecticut.

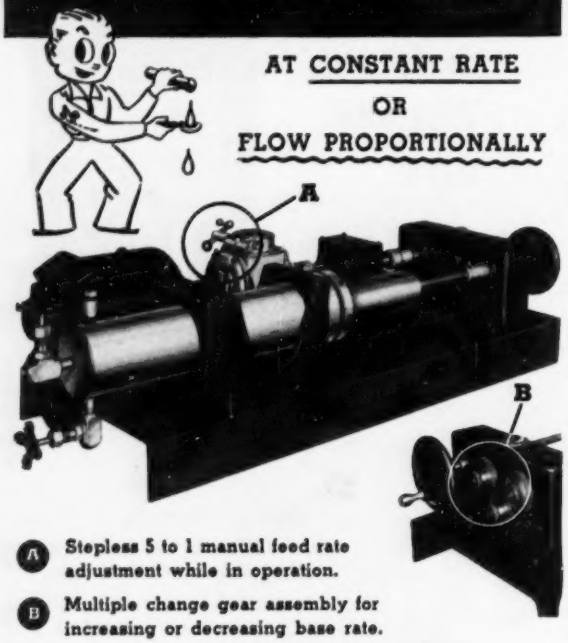
M.3.7

CUNO ENGINEERED FILTRATION

For more information circle **26** on inquiry card.

FOR
MICROMETER ACCURACY
IN FLUID FEEDING

AT CONSTANT RATE
OR
FLOW PROPORTIONALLY



Ⓐ Stepless 5 to 1 manual feed rate adjustment while in operation.

Ⓑ Multiple change gear assembly for increasing or decreasing base rate.

Proportioneers Micro-Feeder answers the special needs of pilot plant or laboratory operations requiring continuous small quantity feeds with "absolute" accuracy, independent of viscosity or system pressure variations. Here is a compact, accurate charging system or test unit which gives uniform, reproducible conditions and quick, accurate prediction of the full scale end result.

A precision ground plunger is forced into the fluid-filled cylinder at a readily adjustable, pre-determined rate. Since the fluid is forced out of the cylinder by the uniform progress of the screw-driven plunger, there can be no fluid loss due to valve action or changes in rate of plunger reciprocation. The cylinder may be jacketed or insulated to maintain uniform conditions. The standard Micro-Feeder is available in models for feeding from 1.0 cc to 800 cc per hour and for maximum discharge pressures up to 2000 psig. Special Micro-Feeders can be furnished for other conditions. Ask for recommendations and Bulletin SM-3005-2. Proportioneers, Inc., 422 Harris Ave., Providence 1, R. I.

APPLICATIONS

1. Catalyst Testing
2. Additive Injection
3. Carburetion of Fuels
4. Explosive Mixture Analysis
5. Calibration of Instruments
6. Porosity Determination
7. Laboratory Titration
8. Toxicity Measurements
9. Injection of Vitamin Concentrates

PROPORTIONEERS
DIVISION OF B-I-F INDUSTRIES, INC.
METERS FEEDERS CONTROLS

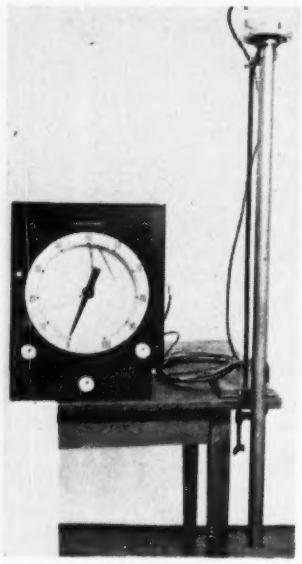
Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.

For more information circle 27 on inquiry card.

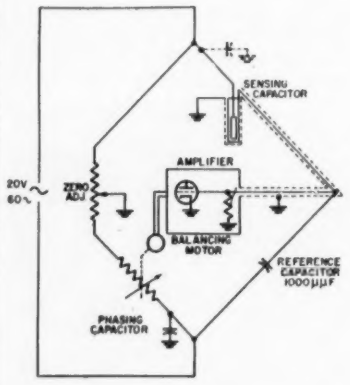
ON THE MARCH—CONTINUED

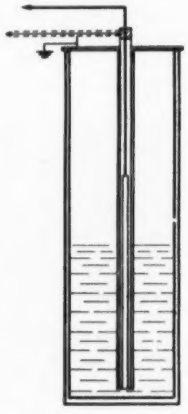
education. Enrollees who complete the two-year course will receive an M.S. degree in systems engineering, the first such degree ever awarded by the university.

Low-temperature Liquid-level Indicator



WASHINGTON, D. C. —A low-temperature instrument that measures, indicates, records, and controls the level of liquefied gases has recently been developed at the National Bureau of Standards with the cooperation of the Brown Instrument Division of Minneapolis-Honeywell Regulator Co. This electronic instrument operates on the capacitance principle and makes use of the difference in dielectric constants of the liquid and vapor states. The sensing element is a vertical cylindrical cacapitor whose capacitance is a function of the height of the liquid refrigerant column. The instrument is designed to be used interchangeably with hydrogen, nitrogen, oxygen, or helium merely by changing sensitivity and range controls. It also incorporates a control system that maintains the liquid level at a predetermined point.





Reversible-thread Plug Gages

CHICAGO, ILL.—Reversible-thread plug gages have been recommended by the American Gage Design Committee. The gages offer these advantages: (1) They are straight pieces rather than taper-shank which permits reversing the ends when worn in pin-vise type of handle. (2) By cutting off worn ends, the wear life of the gage can be lengthened indefinitely. (3) Pin-vise handle with no slippage makes the entire plug surface useable. (4) Control of the length of the gage with the reversible handle is important in determining

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Instrumentation for the Process Industries (Proceedings Seventh Annual Symposium on Instrumentation for the Process Industries, School of Engineering, Agricultural and Mechanical College of Texas) 1953, 8" x 11¼", 68 pages. Price $2.00

Instrumentation for the Process Industries (Sixth Symposium) 1952, paper, 8" x 11¼", 64 pages. Price $2.50

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Ophthalmic Glossary by R. Goldman, M.D., 1952, paper, 40 pages. Price $2.50

The Electronic Control Handbook by R. R. Batcher & Wm. Moulic, 1952, paper, 244 pages. Price $3.00

Pittsburgh International Conference on Surface Reactions (twenty-eight papers presented) paper, 8½" x 11", viii + 236 pages. Price $10.00

Stress Corrosion of Mild Steel by James T. Waber & Hugh J. McDonald, 1947, paper, 5¾" x 8¾", vi+ 94 pages. Price $2.00

Instrumentation for the Iron & Steel Industry (Proceedings First Annual Conference on Instrumentation for the Iron & Steel Industry, Carnegie Institute of Technology and the Pittsburgh Section, Instrument Society of America) 1951, paper, 8" x 11¼", 52 pages. Price $2.00

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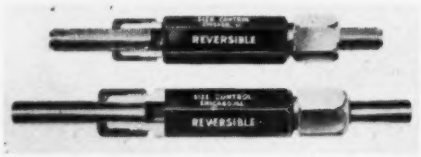


the working length of the gage for holes of various depths. The depth of a hole in a piece part may often be checked by allowing the gage member to extend from the handle only the required hole depth. Reversible-thread plug gages were originated by Size Control Co., 2500 W. Washington Blvd., Chicago 12, Ill.

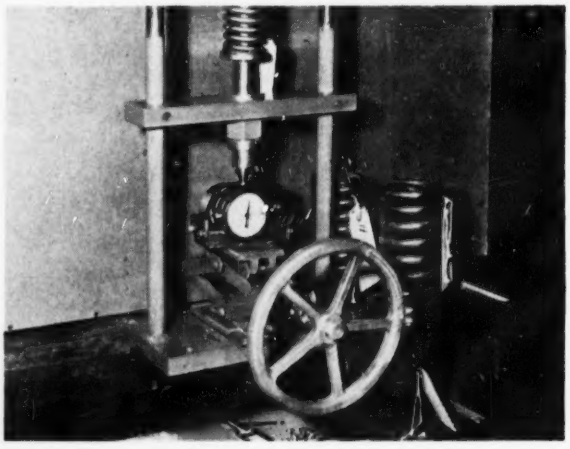
Power-machinery Safety

CLEVELAND, OHIO.—The operators of this power shear at a Cleveland plant are protected by a "Curtain of Light." A projector produces a pulsed beam of light, one inch in

diameter, across the danger zone. If an operator cuts the beam, the shear stops. A pulsed beam is used to make the device insensitive to ordinary light. The projector and receiver are indicated by arrows. The instrument is made by Electronic Control Corp., 1573 E. Forest Ave., Detroit, Mich.

Spring Calibration

PALISADES PARK, N. J.—An inexpensive way of testing compression coil springs has been developed by the Farris Engineering Corporation of Palisades Park, New Jersey, manufacturers of precision safety and relief valves. A Dillon Mechanical Pressure Gage is placed on a scissors-type jack to which a hand wheel has been attached. A hydraulic jack is also used at times. The spring to be tested is



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The complete line of POWERSTATS type 136 and 236 will be on display at the 1954 Radio Engineering Show to be held March 22-25 at the Kingsbridge Armory in New York. Visit The Superior Electric Company's exhibit in Booths 100, 101, 102, 103, 104.

SEE OTHER SIDE FOR MORE FACTS

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POWERSTATS type 136 and 236 are available in numerous models to meet the requirements of individual applications. Single and three phase assemblies are offered for manually-operated and motor-driven duty in 120, 240 and 480 volt ratings. There are types with exposed terminals, output receptacles, input cord-plugs, fused output — all the features desired for the ultimate in variable transformer design. Write for Bulletin P354.

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RATINGS – STANDARD POWERSTATS TYPE 136 AND 236

	LINE VOLTAGE	OUTPUT VOLTAGE	MAXIMUM OUTPUT AMPERES	FREQUENCY	TYPE CONNECTION	POWERSTAT TYPE
SINGLE PHASE	120	0-120/140	20	50/60	Exposed Terminals	136
	120	0-120/140	20	50/60	Enclosed Terminals. Fused	F136
	120	0-120/140	20	50/60	Two-Wire Parallel-Bladed Receptacle, Cord & Plug. Fused	2PF136
	120	0-120/140	20	50/60	Three-Wire Parallel-Bladed Receptacle, Cord & Plug Grounded. Fused	3PF136
	120	0-120/140	20	50/60	Two-Wire Twist-Lock Receptacle, Cord & Plug. Fused.	2TF136
	120	0-120/140	20	50/60	Three-Wire Twist-Lock Receptacle, Cord & Plug Grounded. Fused	3TF136
	120	0-120/140	40	50/60	Exposed Terminals	136-2P
	120	0-280	9*	50/60	Exposed Terminals	236
	240	0-240/280	9	50/60	Exposed Terminals	236
	240	0-240/280	9	50/60	Enclosed Terminals. Fused	F236
	240	0-240/280	9	50/60	Two-Wire Parallel-Bladed Receptacle, Cord & Plug. Fused	2PF236
	240	0-240/280	9	50/60	Three-Wire Parallel-Bladed Receptacle, Cord & Plug Grounded. Fused	3PF236
	240	0-240/280	9	50/60	Two-Wire Twist-Lock Receptacle, Cord & Plug. Fused	2TF236
	240	0-240/280	9	50/60	Three-Wire Twist-Lock Receptacle, Cord & Plug Grounded. Fused	3TF236
	240	0-240/280	20	50/60	Exposed Terminals	136-2S
	240	0-560	9*	50/60	Exposed Terminals	236-2S
	480	0-480/560	9	50/60	Exposed Terminals	236-2S
THREE PHASE	120	0-120/140	20	50/60	Exposed Terminals	136-2D
	120	0-280	9*	50/60	Exposed Terminals	236-2D
	240	0-240/280	9	50/60	Exposed Terminals	236-2D
	240	0-480	20	50/60	Exposed Terminals	136-3Y
	240	0-560	20	60	Exposed Terminals	136-3Y
	240	0-560	9*	60	Exposed Terminals	236-3Y
	480	0-480	9	50/60	Exposed Terminals	236-3Y
	480	0-560	9	60	Exposed Terminals	236-3Y

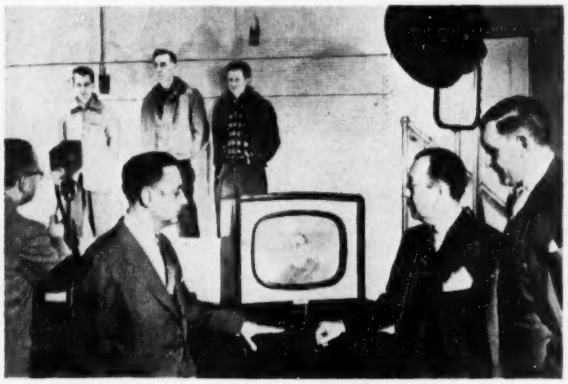
*Output current rating applies only at output voltages less than 125% of line voltage. At higher output voltages, the allowable current drops off according to published curve.

The SUPERIOR ELECTRIC Company 703 CLARKE AVENUE, BRISTOL, CONNECTICUT

placed on a movable platform, or spring washer, which is part of a telescoping bar. Turning the hand wheel raises the jack, and force is applied through the gage to the telescoping bar, thus compressing the spring upwardly against the underside of a fixed platform. A fixed scale adjacent to the moving bar permits measurement of deflection. By this means, an accurate reading of load and deflection characteristics of the spring is obtained quickly.

Police Use ITV

NEW YORK, N. Y.—An industrial TV system has been put to work by the law-enforcement activities of New York City. Images picked up by a TV camera in the "line-up" room at New York Police Headquarters are transmitted by microwave to a relay booster atop the Empire State Build-



ing, from which point they are retransmitted to Brooklyn and other police headquarters in each precinct. This makes it possible for all city detectives to participate in identification without leaving their precincts. The system used is an RCA ITV-5 system.

Other recent uses of ITV in law enforcement include continuous watch on cells in the city jail of Houston, Texas, and the trapping of thieves in Los Angeles, Calif.

Tank Eyes

ANAHEIM, CALIF.—Only recently released by the U. S. Army Ordnance Corps is this photograph of the new high-speed, more accurate T-46 optical range finder (inset)

which serves as the sighting and aiming device for the Army's newest tank, the Patton 48, shown above. Now being produced by the Anaheim (Calif.) Division of Northrop Aircraft, Inc., this latest range finder is capable of greater accuracy and operates in conjunction with a T-30 ballistics computer, also produced at Northrop-Anaheim, to bring the tank's 99-mm. gun onto a target quickly.

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QUICK ACTING FOR MINIMUM PRESSURE VARIATION

When you need "on-the-button" steam pressure reduction, specify the new Klipfel Pilot-Operated Reducing Valve.

Although extremely sensitive, its simple operation insures trouble-free service. Downstream pressure is sensed by the diaphragm of the pilot valve. The pilot valve uses upstream pressure to open the main valve if downstream pressure is too low; if too high, pressure is bled off to partially close main valve.

The next time you order a reducing valve, get the new standard for accurate control and low cost operation . . . Klipfel No. 933 Reducing Valve. Detailed literature on request.

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No. 1549
Pilot - operated Temperature Regulating Valve . . . sensitive, positive control for high pressure, larger sizes.

No. 1649
Combination Temperature and Pressure Control...single main valve with temperature and pressure control saves cost and labor!

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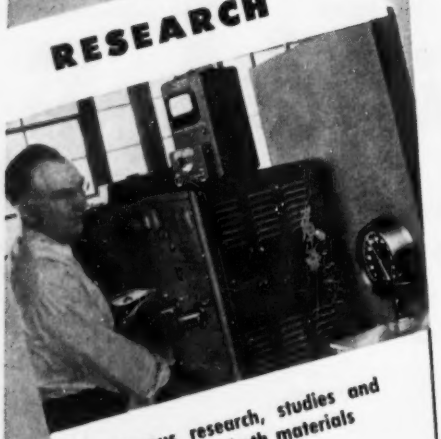
RESEARCH



Continuous research, studies and tests guarantee both materials and methods.

Completed designs as well as individual components are subjected to "breakdown" tests in the Research Laboratory pictured here. These tests subject all materials and methods to vigorous analyses . . . are designed to keep Ashcroft ahead of future as well as current gauge requirements regardless of industry demands.

Separate an Ashcroft Gauge into its component parts and many of the reasons that have made it the leader for over a century remain unseen. For they are invisible values . . . equally as important to the sustained high accuracy and long-life endurance of the gauge as the Bourdon Tube, the movement, linkage, case and other components.

Creative research, highly functional design, quality control of both materials and methods and rigid manufacturing standards are "built into" every Ashcroft Gauge . . . are the fundamental reasons why high performance standards are expected and attained in every gauge bearing the Ashcroft Shield.

The new Ashcroft Gauge Catalog 300 is now available. Write for a copy.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR is thoroughly acquainted with the various lines of Ashcroft Gauges. You can depend on him to help you in selecting the right type for your particular needs—and to deliver promptly.

ASHCROFT GAUGES

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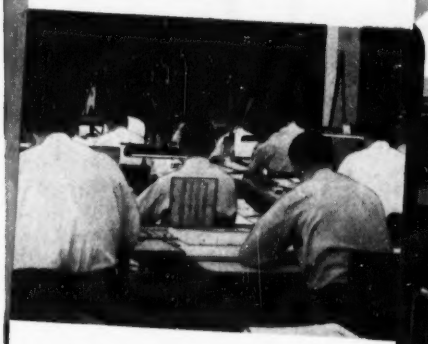
# of ASHCROFT GAUGES

1850 ASHCROFT U.S.A.

DESIGN



Sustained accuracy is the major objective of the design function.

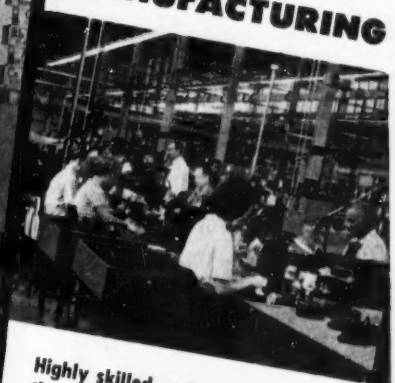
Where research largely determines materials and methods to be used, the design function is primarily concerned with sustained high accuracy. The drafting room shown above is one of the most essential "creative centers" in the progress of an Ashcroft Gauge from original research to finished product.

QUALITY CONTROL

Ashcroft metallurgists subject all raw materials and parts to thorough examination and tests.

Augmenting research and design, quality control exhaustively examines, for functional surety, all materials used in the gauge as well as the finished product. No substitute for final inspection, quality control "guards the gauge" from original design to final manufacture.

MANUFACTURING



Highly skilled craftsmen command the most modern equipment and plant facilities to assure manufacturing excellence.

This unbeatable combination produces the Ashcroft Gauge . . . an achievement in metal . . . first conceived by Ashcroft research and design engineers and completed by unmatched production techniques. Pictured is one of the assembly sections where perfection of gauge performance is considered a manufacturing challenge as well as a responsibility.

1850 ASHCROFT U.S.A.

A PRODUCT OF MANNING, MAXWELL & MOORE, INC.

STRATFORD, CONNECTICUT

MAKERS OF 'ASHCROFT' GAUGES, 'HANCOCK' VALVES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

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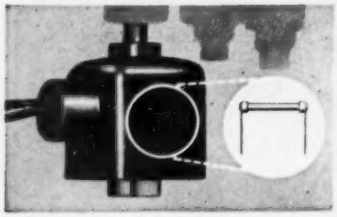
News About Created-Metals

Thermistors Provide Vital Time Delay

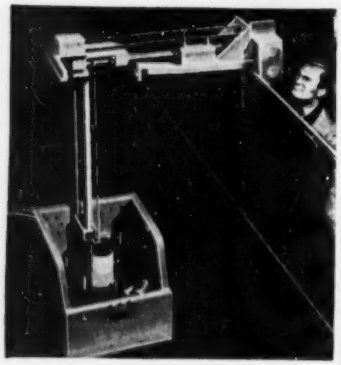


Smoky starts, puff-back and flutter in oil burners were checked by using a Carboloy Thermistor in the burner's electrical control.

The Thermistor delays the opening of a solenoid valve until the combustion chamber is ready to receive properly aerated oil. A mechanical timer is eliminated, and the cost of the unit reduced.

Thermistors are the most thermally sensitive resistor material known. Their resistance – unlike metals – changes negatively with temperature increases. They are ideal for temperature compensation, temperature detection, warning devices and controls. For more information, write: Carboloy Department of General Electric Company, 11155 E. 8 Mile Road, Detroit 32, Michigan.

Hevimet Containers Stop "Hot Atoms"

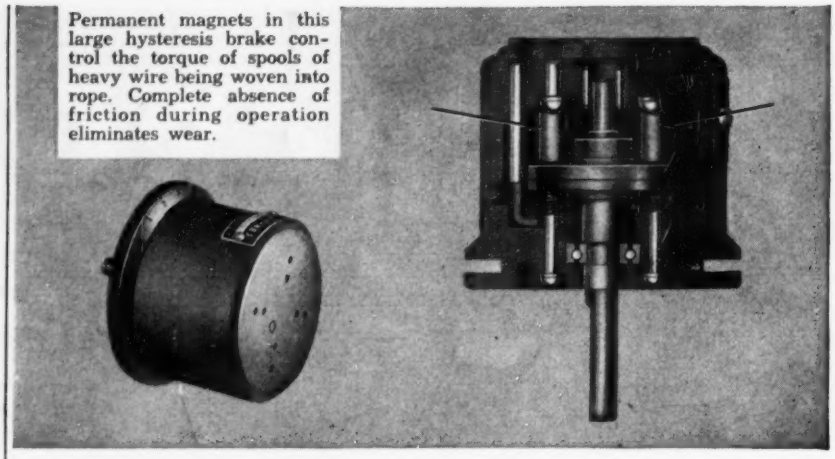


Containers made of Carboloy Hevimet are making the job of handling and transporting radioactive materials easier and safer.

Because Hevimet is almost 50% heavier than lead, and provides 40% more gamma ray protection, these containers are smaller, less bulky . . . yet safer than lead.

Hevimet is an ideal material for all radioactive shielding. It is readily machinable, dimensionally stable and of high tensile strength. For more information, write: Carboloy Department of General Electric Company, 11155 E. 8 Mile Road, Detroit 32, Michigan.

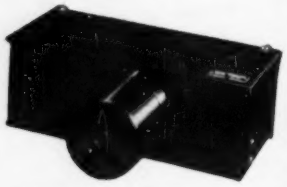
Permanent magnets in this large hysteresis brake control the torque of spools of heavy wire being woven into rope. Complete absence of friction during operation eliminates wear.



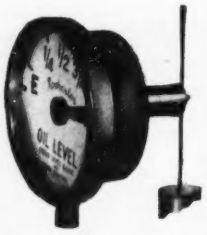
Control Torque

Basic functions of permanent magnets

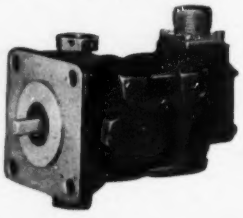
1	Change electrical energy to mechanical motion	Eddy current braking Motor action Instrument action
2	Change mechanical motion to electrical energy	Generator action Magneto action
3	Change mechanical energy to thermal energy	Control of torque
4	Mechanical holding	Snap action Separation Holding and lifting



Minneapolis-Honeywell Step Controller employs snap switch based on mechanical holding function of Carboloy Alnico permanent magnets. Magnets reduced weight, improved design, and increased performance.

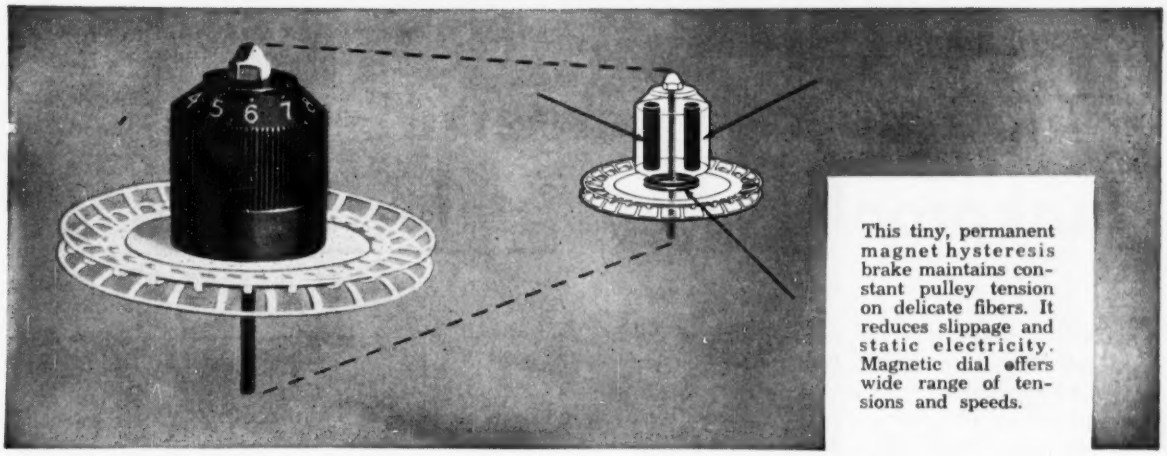


G.E. jet tachometer generator had to be kept small and light. Engineers used permanent magnet's ability to change mechanical motion to electrical energy. Magnets eliminated coils and wires; provided powerful energy.



Rochester Liquid Level Gauge utilizes synchronous magnetic torque drive principle to operate pointer, keep gauge head pressure-tight. Magnets eliminate stuffing box and shaft – permit mounting gauge in any position without danger of leakage.

For more information circle 33 on inquiry card.



This tiny, permanent magnet hysteresis brake maintains constant pulley tension on delicate fibers. It reduces slippage and static electricity. Magnetic dial offers wide range of tensions and speeds.

with Permanent Magnets

In hysteresis brakes, permanent magnets convert mechanical energy to thermal energy. Other inherent properties make permanent magnets ideal for many electrical and mechanical applications.

Carboloy Alnico permanent magnets, in hysteresis brakes, provide smooth, frictionless torque control. Tension and torque are adjustable and constant.

The hysteresis brake is only one of the ways permanent magnets can control torque. And permanent magnets can be used to convert electrical energy to mechanical motion . . . or mechanical motion to electrical energy, or for mechanical holding.

Permanent magnets offer many production savings. They can eliminate parts, reduce costs, simplify design, save weight and improve performance. They retain their efficiency under varying conditions of temperature, shock, vibration. They resist the demagnetizing influence of stray magnetic fields . . . provide powerful, permanent energy sources. Available in all sizes and shapes, cast or sintered.

Perhaps Carboloy permanent magnets can improve your products or equipment. Specially trained engineers of the Carboloy Engineering Appraisal Service will work with you on permanent-magnet design and application. Send coupon, today, for free catalog or design manual.

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"Tube up and forget it" with leakproof Parker *Triple-lok* Fittings

Cramped and crowded, nobody likes to do this kind of a job over again. That's why trouble-free Parker *Triple-lok* fittings were used. Since this hydraulic test stand was completed, it has run over a billion impulse cycles at 3000 psi. without a single leak at any *Triple-lok* fitting.

These flare fittings are absolutely leakproof even under the severest conditions of vibration, high pressures and temperatures. Thousands of destruction tests prove that they will hold pressures that burst the tubing. And, they remain leakproof no matter how often you reassemble them!

Using *Triple-lok* fittings is also the easiest and fastest way to tube up your system even in close quarters. Flared tubing simplifies installation. For fitting make-up, you need only a small wrench because assembly torque is so low.

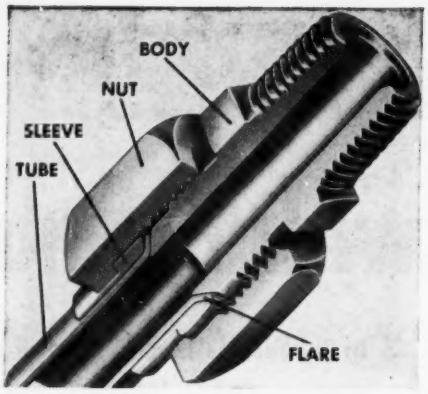
These fittings meet J.I.C. and S.A.E. standards plus specifications of the A.S.M.E. Code for Pressure Piping.

As a matter of fact, *Triple-lok* is the standard of industry. More *Triple-lok* fittings are used on industrial machinery than any other fitting.

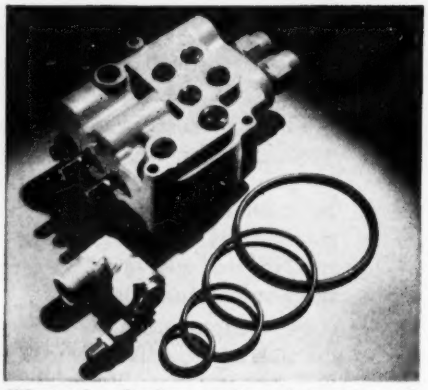
So, tube up and forget it. Use *Triple-lok* throughout your plant. Parker offers the widest range of shapes and sizes available . . . for tubing outside diameters from ⅛ through 2 inches. Ask your distributor for Catalog No. 4300.

TUBE AND HOSE FITTINGS DIVISION
The Parker Appliance Company
Section 404Q, 17325 Euclid Avenue, Cleveland 12, Ohio

Parker
Hydraulic and fluid system components



3-piece Triple-lok fittings are stocked in steel, stainless steel, brass, and aluminum alloy —available in other materials on special order.



What other Parker products interest you? Ferulok flareless fittings? Hydraulic control valves? O-rings? Write Parker for information.

CALL YOUR NEAREST DISTRIBUTOR FOR PARKER INDUSTRIAL FITTINGS

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Baltimore 5, Md.	Whitehead Metal Products Co. 4300 E. Monument St.
Beaumont, Tex.	Standard Brass & Mfg. Co 705 Milam St.
Birmingham, Ala.	Mill & Textile Supply, Inc. 3128 Third Ave. South
Boston 15, Mass.	A. E. Borden Co., Inc. 176 Brookline Ave.
Bryson City, N. C.	Wallace Co. of N. C. P. O. Box 572
Buffalo 7, N. Y.	Whitehead Metal Products Co. 2128 Elmwood Ave.
Cambridge 39, Mass.	Whitehead Metal Products Co. 281 Albany St.
Cedar Rapids, Ia.	Globe Machinery & Supply Co. 309 8th Ave. S. E.
Charleston, W. Va.	Persingers, Inc. 514 Elizabeth St.
Charlotte 1, N. C.	Industrial Piping Supply Co. 1501 Dowd Rd.
Chicago 14, Ill.	Wallace Tube Co. 1300 Diversey Parkway
Cincinnati 25, Ohio	Williams & Co. 3231 Fredonia Ave.
Cleveland 14, Ohio	B. W. Rogers Co. 1279 East 12th
Cleveland 14, Ohio	Williams & Co. 3700 Perkins Ave.
Columbus 5, Ohio	Williams & Co. 851 Williams Ave.
Dallas 9, Tex.	Metal Goods Corp. 6211 Cedar Springs Rd.
Davenport, Ia.	Globe Machinery & Supply Co 410 E. Second St.
Dayton 10, Ohio	J. N. Fauver Co. 1534 Keystone Ave.
Denver 2, Colo.	Metal Goods Corp. 2425 Walnut St.
Des Moines 8, Ia.	Globe Machinery & Supply Co. East First & Court Ave.
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Harrison, N. J.	Whitehead Metal Products Co. 1000 South Fourth Ave.
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Houston 1, Tex.	Standard Brass & Mfg. Co. 2018 Franklin St.
Indianapolis, Ind.	Avels Sales & Engineering Co. 16 W. 22nd St.

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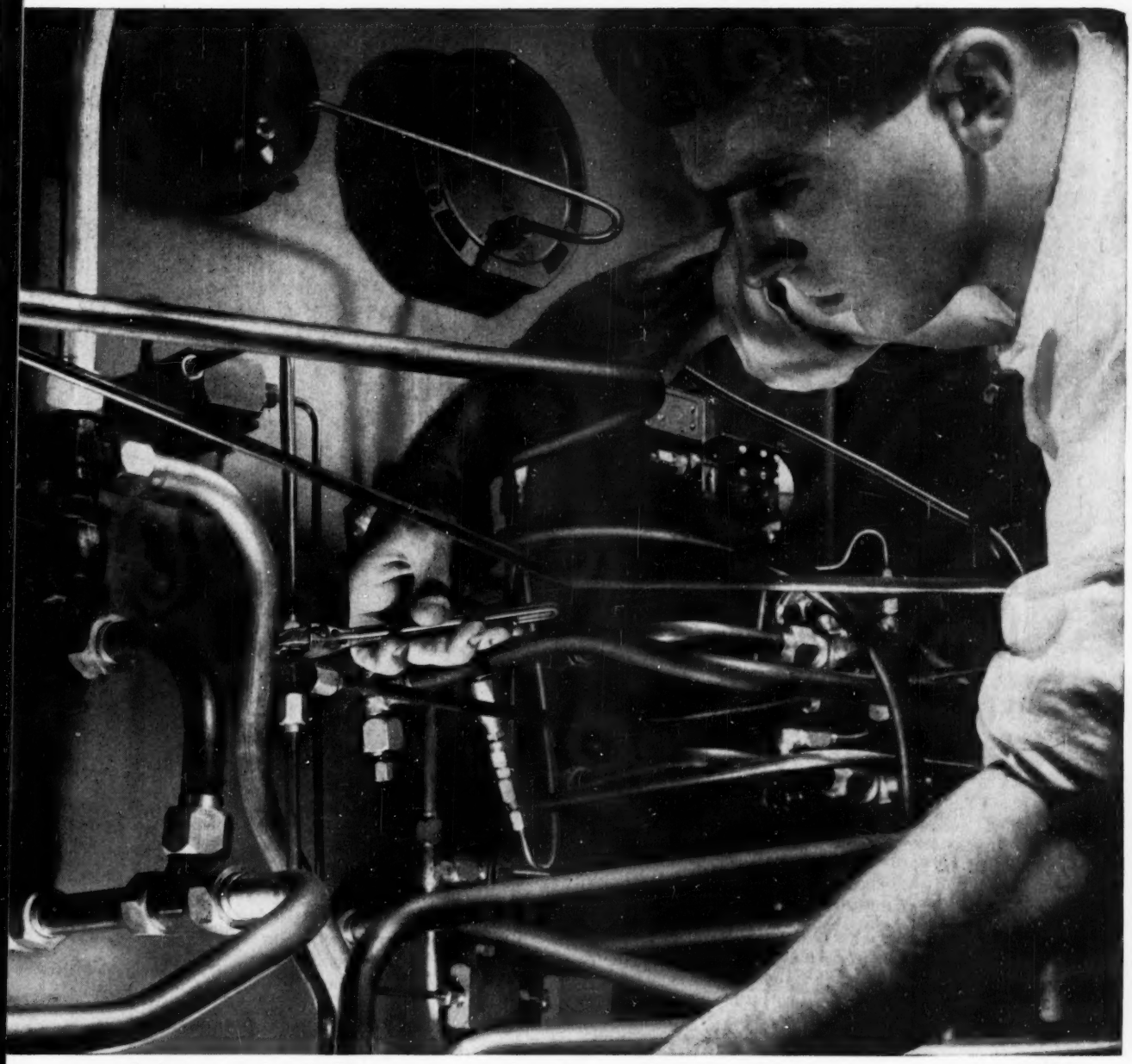

Easiest way to install tubing, even in cramped quarters, is to use Parker *Triple-lok* flare fittings. Assembly torque is so low that you need only a small wrench for fitting make-up. The self-aligning sleeve acts as a lock washer, supports the tube, and damps vibration. *Triple-lok* is absolutely leakproof even under high pressures and temperatures.

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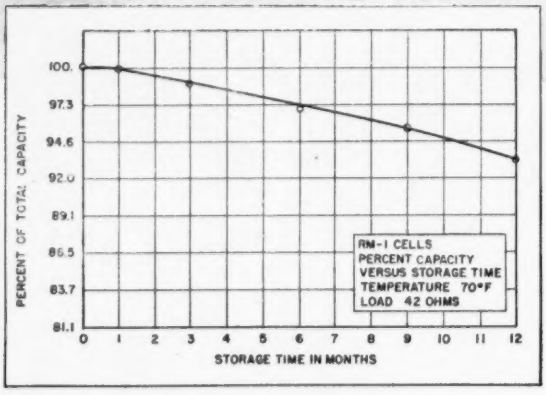
For Long Shelf Life... Use Mallory Mercury Batteries



For battery-powered instruments that operate intermittently . . . or for applications involving long periods of idleness, the long shelf life of Mallory Mercury Batteries is an important characteristic.

Mallory Batteries do not deteriorate or lose an appreciable amount of power during long storage periods, even under the most adverse conditions of humidity and temperature extremes. The curve shown is typical of the performance you can expect when Mercury Batteries are used for instrument power supply.

For continuous or intermittent operation at microampere drains or loads of 50 amperes, Mallory Mercury Batteries have many important advantages that will help you design lighter, more compact equipment . . . equipment that will give more hours of service life.

Let us send you a copy of our new Technical Bulletin 1-6. It contains complete information on single cells and multi-cell stacks and packs.

Here are other advantages that may suggest ways you can use Mallory Mercury Batteries to advantage

- High ratio of energy to volume and weight
- Leak-proof, dimensionally stable construction
- Uniform discharge characteristics
- No need for recuperation periods
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- Resistance to humidity and corrosive conditions
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For Transistor Applications

The constant voltage-constant current characteristics of Mallory Mercury Batteries make them exceptionally well suited to transistor applications.

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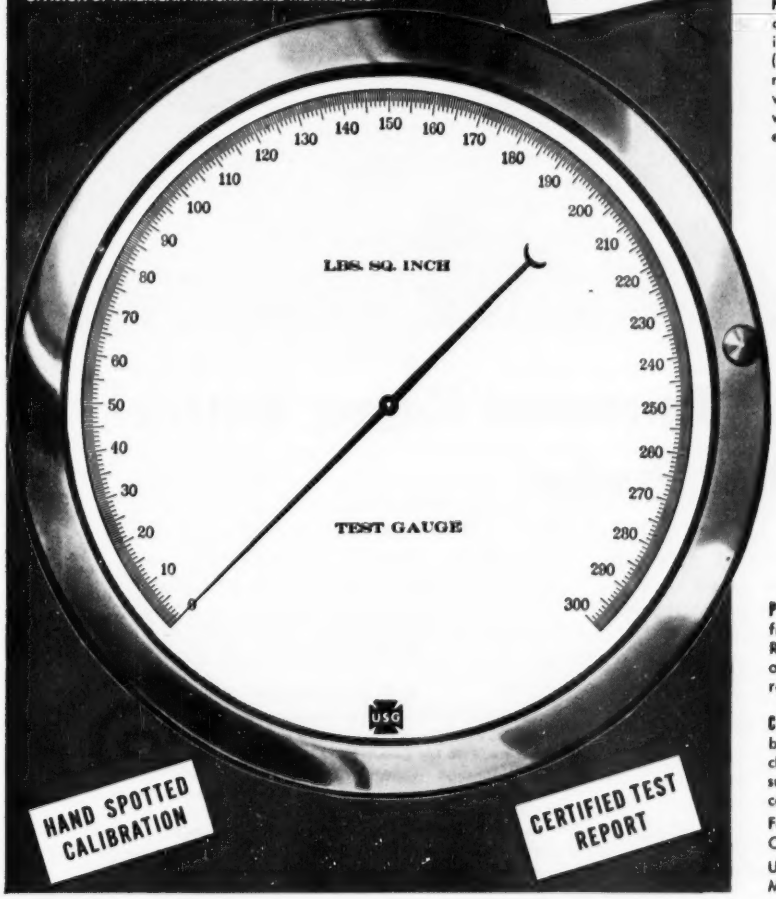
Wherever you require *peak precision* from a gauge—for compression or tensile strength testing machines, or for replacing or supplementing dead weight testers or manometers—you can use the accuracy of USG Laboratory Test gauges to advantage.



PEAK PRECISION—½ of 1% of the indicated reading above 20% of the maximum dial range and one part in 500 (0.2%) below 20% of the maximum dial range. A Certified Test Report is furnished without charge for applying corrections when instrument is used at accuracies higher than ½ of 1% of indicated reading.

PRECISION DRAWN TUBE—Drawn from phosphor bronze, beryllium copper, or 403 stainless steel—depending on pressure range. All tubes are specially treated to produce minimum hysteresis and drift.

PRECISION MOVEMENT—Aircraft quality for highest sensitivity. Nickel-dipped bronze with extra long bearings and heavy bronze bushing fitted with nickel silver pinions and arbors.

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For additional information, write for USG Catalog 64.

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OTHER DIVISIONS OF AMERICAN MACHINE AND METALS, INC. AT SELLERSVILLE, PA.: GOTHAM INSTRUMENTS, AND AUTOBAR SYSTEMS.

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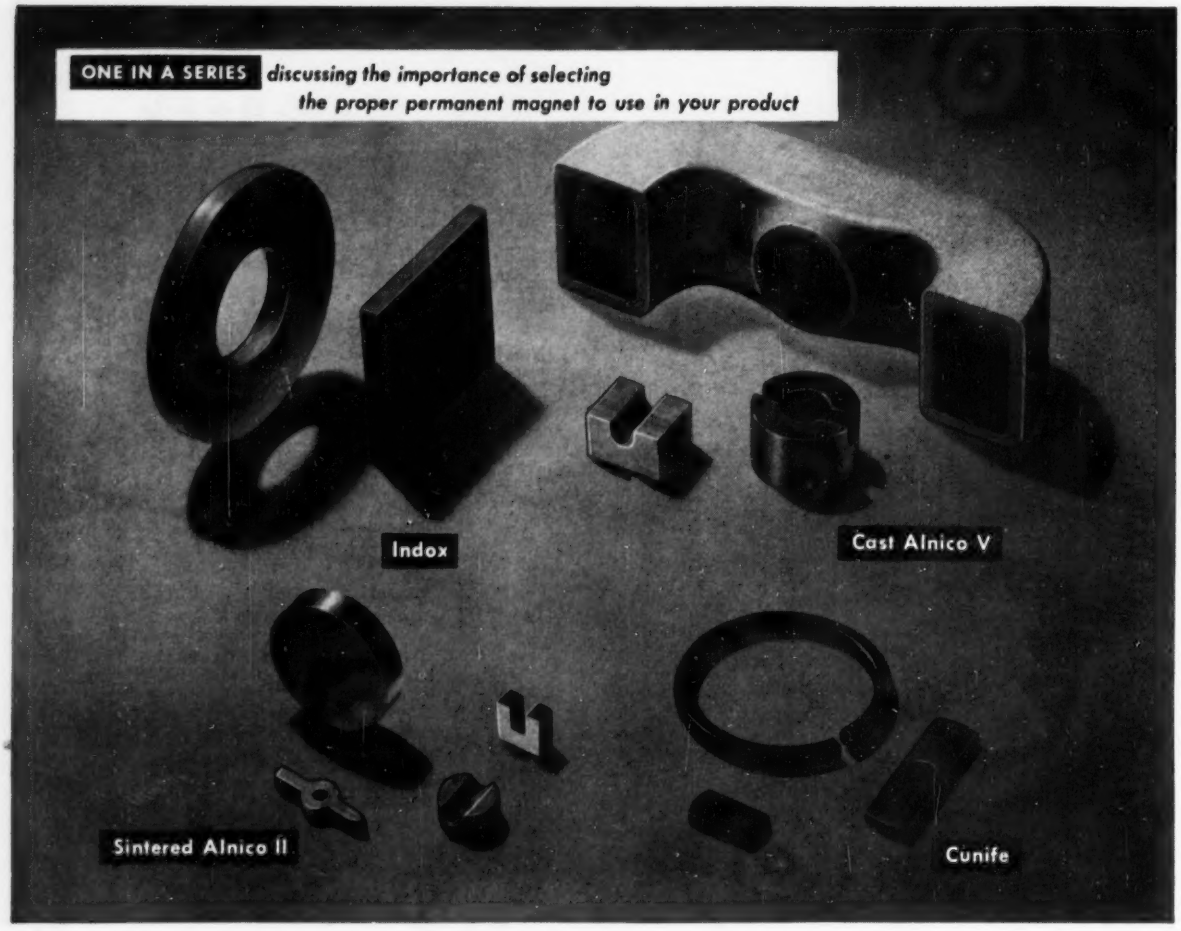
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How the Right* Permanent Magnet Material Can Benefit Your Product

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Which one is it? To help you answer that question properly is part of our job. As specialists in permanent magnets, we have helped to provide manufacturers with the answers for over 35,000 applications. The case of the telephone equipment manufacturer is typical. Perhaps we can assist you, too.

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A Typical Case

. . . is that of a prominent telephone equipment manufacturer who changed from a chrome steel magnet to the use of Alnico III in his polarized relay. The results:

- **70% Savings in initial cost**
- **Simplified design**
- **Reduced weight**
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** The one which will permit your product to function best at the lowest possible cost.*

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designer's INSTRUMENT guide

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6402

Literature on any of the above instruments sent on request. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

WESTON *Instruments*

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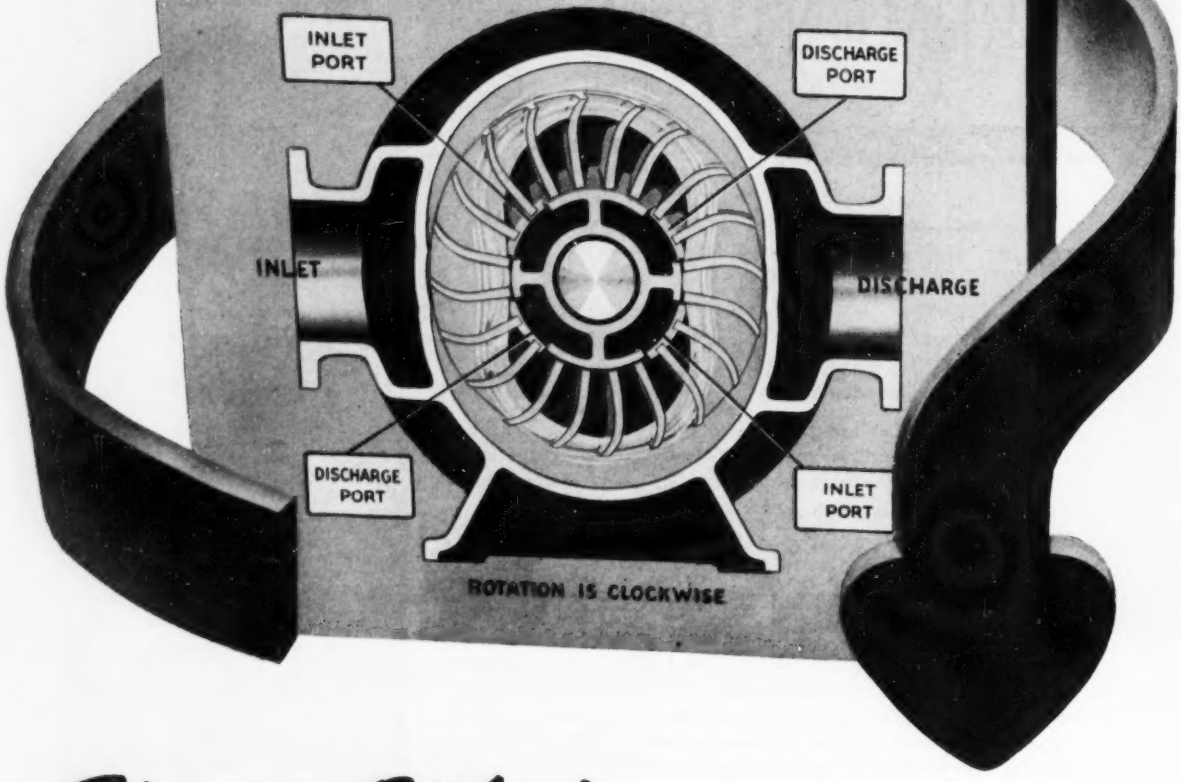
Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

- No oil filters.
- No dust filters.
- No internal lubrication to contaminate air handled.
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- No valves, pistons, or vanes.
- Non-pulsating pressure.
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New oscillographs, four or six channel, fit standard 19-inch racks. Direct ink writing unit shown at left; combination ink and electric writing unit shown above.

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THESE new Brush multichannel oscillographs set a new high in performance. Check these outstanding features:

*** Electrically Controlled Chart Drive:** Multiple chart speeds • Instantaneous switching Remote or local control • Best signal resolution with economy in chart paper.

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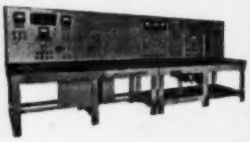

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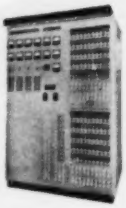

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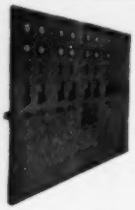

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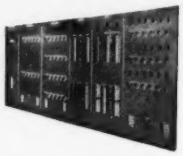

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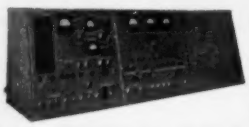

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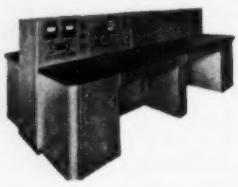

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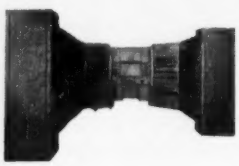

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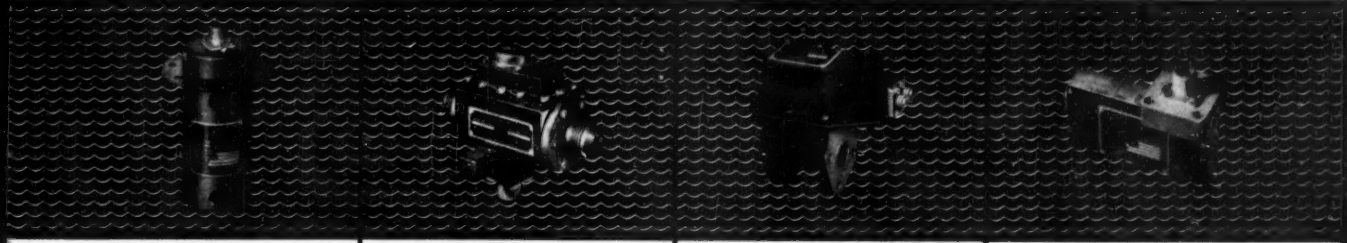
See *Revere* . . . if you need to know — **HOW MUCH LIQUID — HOW LITTLE — AT WHAT LEVEL.** *Revere's* precision made instruments are your unfailing eyes that see into sealed tanks, tubes or complex fuel lines. They can provide you with accurate measurement of liquid level regardless of pressure or temperature changes, vibration or rapid acceleration forces, AND they will automatically transmit a warning signal whenever liquid flow or level maintenance varies from a pre-determined value.

These hermetically sealed, magnetically actuated instruments employ balanced float assemblies to minimize false alarms. Compact and light, Revere instruments meet government specifications. They are available in many different configurations, some of which include relays to handle heavy electrical loads. Others are designed for complete submersion in fluids.

*Submit your control problem to our Field Engineering Department today. Revere will provide the instruments to tell you — **HOW MUCH — HOW LITTLE — AT WHAT LEVEL.** Shown below are some instruments that are the seeing-eyes of aircraft and industry.*



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Specially designed with single or dual float systems to provide automatic cut-off control for single point high pressure refueling.

FLOW SWITCH
Provides instantaneous warning signal whenever liquid flow falls below a pre-determined value. It can be mounted in any direction.

INDICATING SWITCH
Records the presence of fluid in a line whether stationary or flowing and transmits a warning signal if fluid condition changes.

FLUID LEVEL SWITCH
Used to maintain accurate high level, low level or constant level control of fuels, water-alcohol mixtures, beverages, etc. and other liquids.

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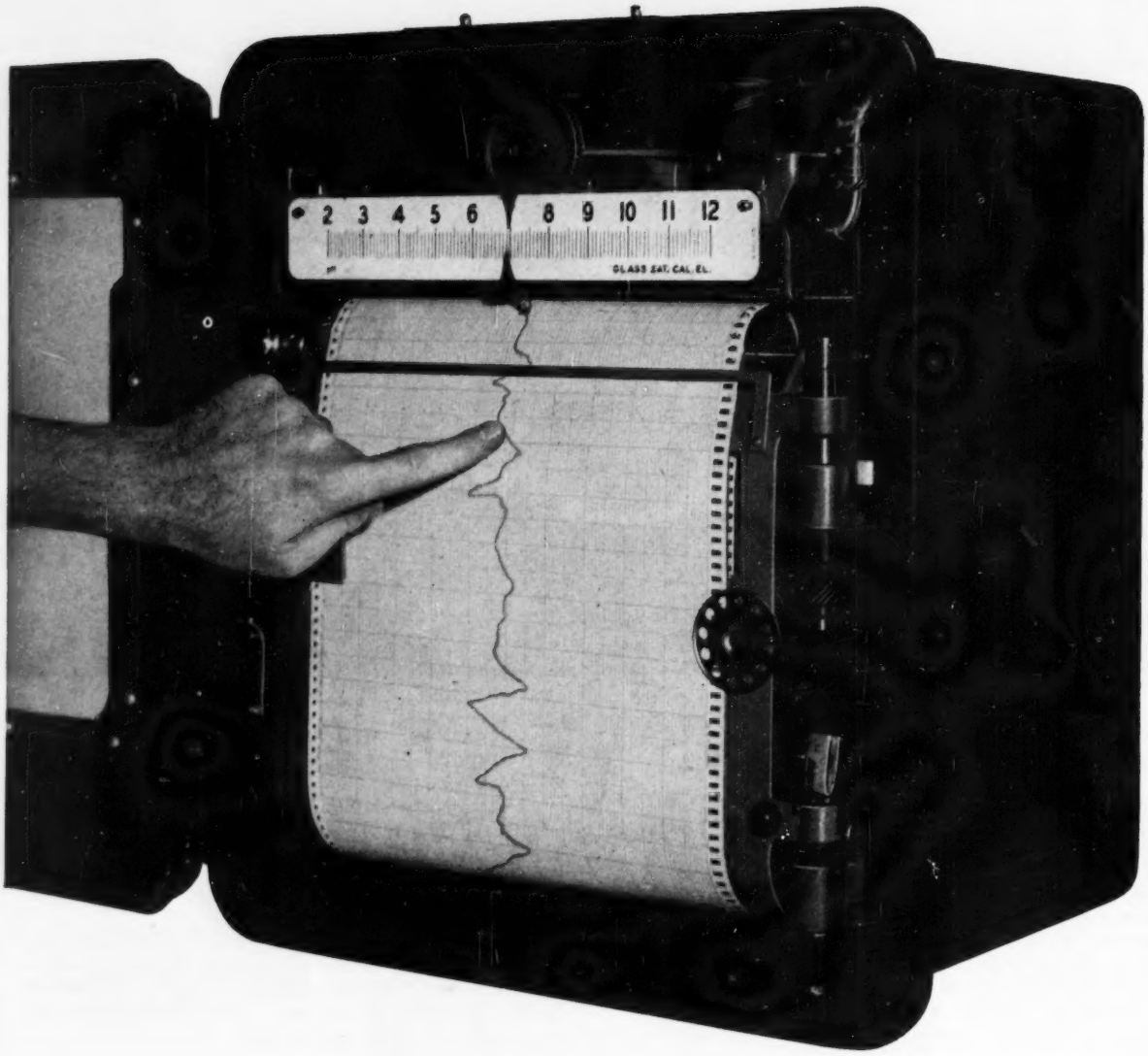

This is the pH record

. . . being achieved by Speedomax® control on a certain neutralizing process. It didn't just "happen". When we were called in, the pH value was roaming all over the map, in spite of the best efforts of an experienced process operator. But difficult as the problem was for the user, it gave way when attacked by our scientific analysis method.

We asked the chemical engineer for specific information. Adequate facts were readily available, pertaining to the plant's raw waste, the layout and retention of the treating system, the characteristics of the neutralizing agent used. We applied our "Controllability Analysis"—proved by thousands of applications—and in less than half an hour, made our recommendations. The record speaks for itself.

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Editorial...

Automation

An extremely important definition—one that poses a serious problem—is the definition of the word "Automation." It may be that there is no EXACT definition which defines all the boundaries of the subject—just as the word "electronics" can not be defined so completely that any one device becomes "electronic" without being "electrical."

The need for a definition of the word automation is serious because many different people are using the word to mean entirely different things—including material handling, machine-tool operation, computer application, etc., etc., etc.

The definition proposed by its original definers was "Automatic Operation." This is so broad a term that one could have expected many different interpretations. However, as readers of *Instruments and Automation*, you have a right to expect a consistency of presentation based on the editorial staff's understanding of a definition of the word automation.

Our concept of automation—as applied to treatment of material in *Instruments and Automation*—refers to the use of automatic control when associated with some type of measurement. The measurement may be based on the direct measurement of any variable, or it may be the error signal representing deviation from a desired control point. This latter, which is by definition the feedback-type controller, definitely includes (1) work positioning—when the position is controlled by feedback-type servos, (2) all instrumentation associated with the basic measurements required to realize any automatically controlled operation, and (3) all methods utilizing servo-type mechanisms operated by error-type signals.

This definition EXCLUDES the conveyor belt, the manually-operated hoist, the conventional lathe or drill press, the drying oven, the wheelbarrow, and the freight car. It INCLUDES the servo-controlled conveyor-belt motor and control system, the servo-controlled hoist mechanism, the lathe or drill press with servo-controlled work-positioning mechanisms, the instrumentation of the drying oven, and the remote control and inspection devices used with the wheelbarrow and freight train, such as industrial television, level controllers, etc.

The principles of servomechanisms are similar to those of conventional automatic controllers. It is the extension of these basic principles—already familiar to the instrument engineers of America—to work positioning, machine tools, and materials handling, that is causing so much confusion in the minds of so many.

Aeronautical Instrument Course

A letter received from the University of Colorado, Boulder, Colorado informs us:

> "Enclosed is a copy of our instruments laboratory manual for the course in Aeronautical Instruments as we give it here using your magazine and handbook as the principal sources of information. I thought you would like to have a copy of this because it is probably one of the very few college courses in which your magazine and handbook are the principal textbook.
>
> "Your cooperation is greatly appreciated and we will report to you on the way this program works out. We believe it will prove very stimulating to the students to be in such close touch with current developments in the field of instrumentation."

A letter to the editor

An engineer who has devoted his last six years to electronic and computer work writes: "In my recent years in computing I have lost contact with the industrial control field. Besides subscribing to your magazine (we get it in our library), have you any suggestions as to contacts which I might make"?

Our answer has an important message:

Dear Reader:

In your letter you state that you have "lost contact with the industrial control field." In the next sentence you say: "Besides subscribing to your magazine (we get it in our library) . . ." Here is the answer to your inquiry. It is obvious that a company subscription is a poor substitute for a personal copy of a publication that is important enough to warrant personal study.

When only one company copy of *Instruments and Automation* is available, it is obvious that key personnel in that firm cannot take time to examine the 200 new instruments that become commercially available each month—any of which might be a solution to a plant or laboratory problem. Key personnel cannot be expected to take time to read the important technical articles and to examine the new applications, new developments, new manufacturers' literature and commercially available instruments that are important for research and production problems. Result: Engineers all over America are losing touch with fields which their companies believe are being watched.

Several companies have solved this problem by providing their engineers with personal subscriptions to *Instruments and Automation*—in addition to the library reference copy. These companies have better assurance that their engineers are maintaining close contact with the modern field of instrumentation—with minimum use of company time.

Thus the answer to your problem is a simple one. Secure a personal subscription to the only magazine that presents the entire field of instrumentation. To assist you, we have provided special group subscription rates. Your company will cooperate with you if you wish them to do so because all companies today realize the importance of instrumentation in maintaining efficient production and research.

Each issue of *Instruments and Automation* contains the country's most extensive news-coverage services on new instruments and manufacturers' literature. Note that the latter is an economical and efficient way to receive much informative literature on any part of the field.

In one year you will receive twelve issues of *Instruments and Automation* plus the *Handbook of Measurement & Control* (which all subscribers will receive free of charge in December 1954). In addition to these 3000 pages on modern instrumentation you will receive all the manufacturers' literature that you request for your needs.

We know of no simpler or more effective answer to your inquiry. It will, of course, require you to spend some reading time, at home, in order to reestablish and maintain contact with the field.

In this issue

The New Jersey Section of ISA conducted a papers contest in May, 1953. Many excellent papers were submitted. We are pleased to bring you the three winners in this issue.

Also significant are (1) the résumé of the entire field of pneumatic controllers, which you will find beginning on page 440, (2) measurement of small liquid flows by viscous-flow technique, page 460, (3) a new technique for transient recording, page 464, and (4) the cost study of a research nuclear reactor, page 467.

The Month's NEW INSTRUMENTS

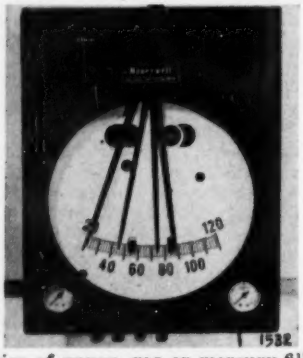
In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 503

PROCESS CONTROL

Duplex Controller

New "Dual Indicating Controller" indicates and controls two temperatures; is available with wet- and dry-bulb thermal systems for humidity;

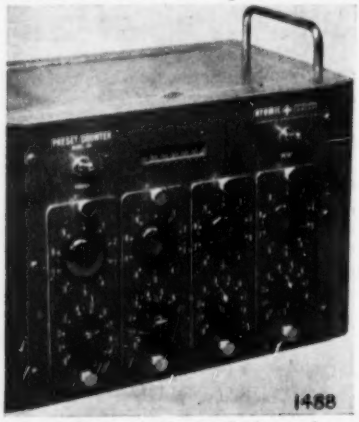


choice of vapor, gas or mercury-filled thermal systems. Measuring-system components and set-point indices are color-coded to their respective pointers.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

For more information circle **201** on inquiry card.

Automatic Count Controller

New "Model 164 Preset Counter" is designed for controlling automatic machinery and processes at speeds up to 5,000 counts per second; closes circuit at instant when predetermined

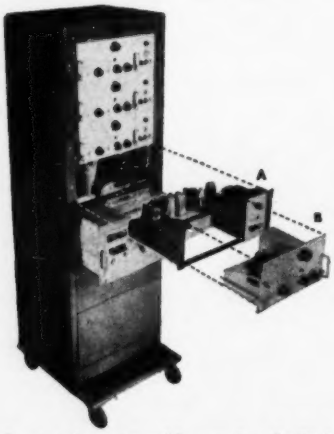


value of count is reached; and recycling may be automatic or by independent control. Can be set to respond to input impulses of either polarity and any voltage between 4 and 60.—*Atomic Instrument Co., 84 Mass. Ave., Cambridge 39, Mass.*

For more information circle **202** on inquiry card.

High-speed Four-stylus Strip-chart Recorder

New "Model 150" four-channel oscillographic recording system is said to provide a unique combination of interchangeable elements for graphic registration of almost any phenomenon (individually or up to four simultaneously) within frequency range of zero to 100 cps. System consists of a vertical cabinet containing a 4-chan-

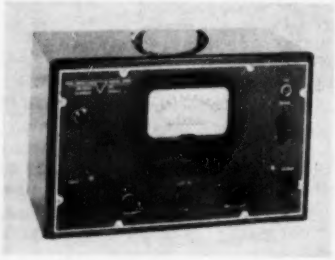


nel recorder assembly, and a built-in driver amplifier and power supply unit (A), which are already in place, for each of the four channels. Preamplifier (B) required for specific application is plugged in to the appropriate channel. Standard "plug-in" preamplifiers now available include: A-c.d-c.; carrier; d-c. coupling; servo monitor; log-audio; and low level. Blank "plug-in" assemblies also available for user to make his own special input circuits. Selection of nine paper speeds (0.25 to 100 mm./sec.)—*Industrial Div., Sanborn Co., 195 Massachusetts Ave., Cambridge 39, Mass.*

For more information circle **203** on inquiry card.

Automatic-control Relay

New "Model 300A Sensitive Electronic Relay" for control of temperature, pressure, flow-rate, etc., is of

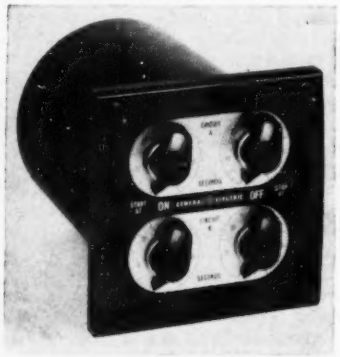


high-ratio type. Control circuit: 6-v. open-circuit voltage, 0.8-microamp rms. short circuit current, 10-megohm resistive impedance. Power circuit: 1500 watts or 2 hp. Relay has normally-open and normally-closed receptacles, and pilot lights for receptacle energization and internal relay operation.—*Deltron Inc., P.O. Box 192, Glenside, Penna.*

For more information circle **204** on inquiry card.

Process Timers

New "Type TSA-18" process timers, for providing adjustable time-delay opening and closing of electric con-

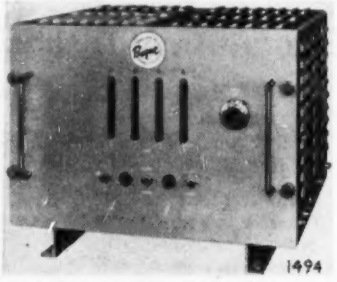


tacts, have been redesigned and improved. Any combination of single- and two-circuit units can be utilized to control 3, 4, 10 or more circuits.—*Meter & Instrument Dep't, General Electric Co., West Lynn 3, Mass.*

For more information circle **205** on inquiry card.

Ultrasonic Liquid Level Indicator System

New "Model SL-102" liquid-level indicator system, using ultrasonic pulse-ranging technique (no moving



parts) indicates liquid levels in processing and storage tanks within 0.01 foot; is also suited to shipboard installations as well as to applications requiring precise location of immiscible-liquids interface. Automatic calibration system compensates for

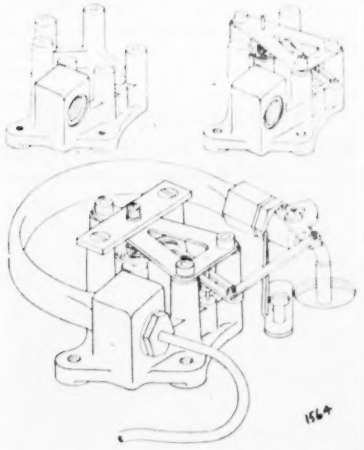
changes in velocity of sound propagation caused by varying temperatures, specific gravities, etc. One common indicator can gage any number of transmitter-equipped tanks within a radius of 2,000 feet; and can feed level data to standard digital tape printers. Tank equipment is explosion-proof.—*Bogue Electric Mfg. Co., 52 Iowa Avenue, Paterson 3, N. J.*

For more information circle **206** on inquiry card.

PRESSURE and VACUUM

High-precision Gages

New models of maker's extreme-precision pressure gages feature two refinements: (1) Integral movement with rigid one-piece base supporting

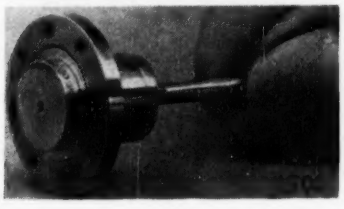


all working parts without dependence on rigidity of case; tube socket an integral part of base casting; dial pivot and support rigidly mounted on base casting independently of movement; (2) unique externally-operated bleeder permitting complete evacuation of air and gas from Bourdon tube when needed, easily accessible at back of case. Three sizes, with 10.31-in., 13.66-in. and 17.69-in. OD.—*Heise Bourdon Tube Co., Inc., Brook Road, Newtown, Conn.*

For more information circle **207** on inquiry card.

Pressure Pickup

New "Type 4-312" pressure pickup is of 4-arm-bridge class; is available in gage, absolute, and differential models; features high corrosion resistance; may be used for either liquid or gaseous media between –65 F. with 250 F. Ranges: 10 to 150 psig. or psia.; ±5 to ±75 psid. with 150-psi. maximum line pressures. Each pickup is individually calibrated and supplied with a calibration certificate. Since either a-c. or d-c. excitation may be used, pickups can be used in a wide variety of controlling, indi-



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in the

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DUO-SEAL® VACUUM PUMP

Ideal for backing-up Diffusions Pumps

GUARANTEED VACUUM
0.0001 mm Hg. or 0.1 Micron

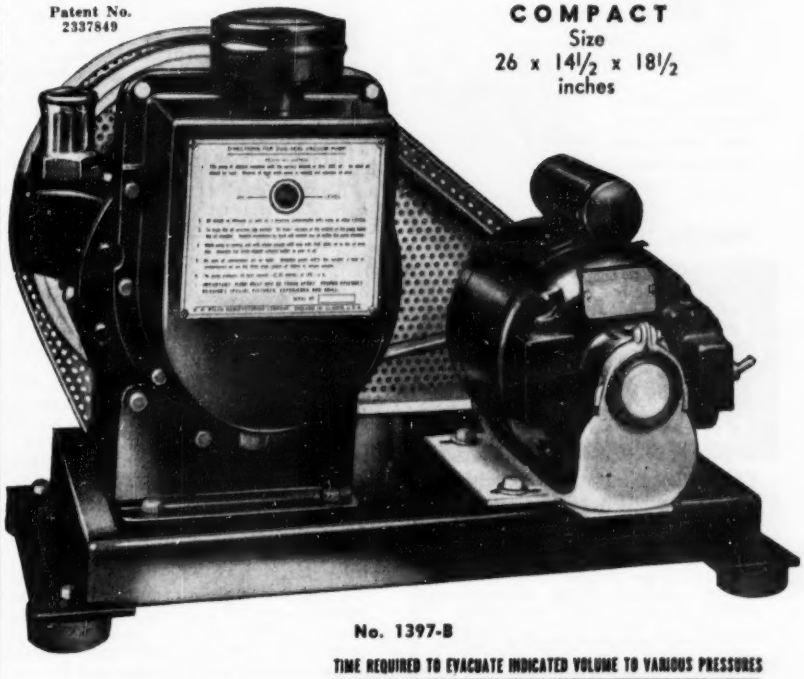
FREE AIR CAPACITY
300 Liters Per Minute

SPEED—152 Liters Per Min. at 1 Micron pressure

QUIET IN OPERATION

Patent No. 2337849

COMPACT
Size
26 x 14½ x 18½ inches



No. 1397-B

TIME REQUIRED TO EVACUATE INDICATED VOLUME TO VARIOUS PRESSURES

PRESSURE mm of Hg. Microns	EVACUATED VOLUME IN LITERS 5-L		10-L		25-L		50-L		100-L	
	Sec	Min	Sec	Min	Sec	Min	Sec	Min	Sec	
10^{0} — 1000	8		17		41	1	23	3	0	
10^{-1} — 100	11		23	1	0	2	0	4	12	
10^{-2} — 10	16		32	1	24	3	0	6	6	
10^{-3} — 1	24		48	2	6	4	16	9	0	
10^{-4} — 01	37	1	14	3	9	6	22	13	54	

1397B. DUO-SEAL PUMP, motor-driven, mounted on cast-iron base with ¾ H. P. 110 volt single-phase motor, with double-groove pulleys, 2 "V" belts, belt tightening device, six feet of connecting cord, snap switch and attachment plug.

COMPLETE $575.00

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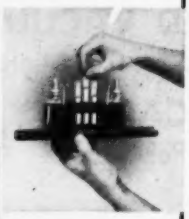
ESTABLISHED 1880

For more information circle **43** on inquiry card.

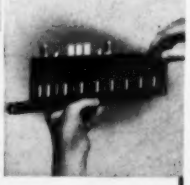
Make Accurate
pH, CHLORINE TESTS
this simple way

A. Fill three test tubes with sample to be tested and place them in base.



B. Add reagent to middle tube only.

C. Place color standard on base, move across until colors match and...



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For more information circle **44** on inquiry card.

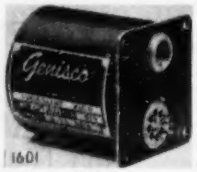
NEW INSTRUMENTS

cating, recording, and telemetering applications. Negligible acceleration response (0.006 to 0.1 percent of full scale per *G*) makes them suitable for aircraft and missile flight tests—*Consolidated Engineering Corporation, Pasadena* 15, *Calif.*

For more information circle **208** on inquiry card.

Pressure Pickup

New "Model GPT" features isolation of voltage-dividing resistor from actuating pressure; is designed primarily as an absolute-pressure pickup but is available also in gage-pressure and differential-pressure types; ranges 15 to 80 psi. Output is linear with pressure or differential.



Windings and brushes are made of precious-metal alloys. Available resistances, 2000 to 10,000 ohms; current rating, 7 ma. for standard elements. Allowable overpressure, 50 percent. Operating temperature –50 C. to 90 C. with less than 2 percent ratio change at extremes. No damage from 40-*G* shock on any axis.—*Genisco, Inc.*, 2233 *Federal Ave., Los Angeles* 64, *Calif.*

For more information circle **209** on inquiry card.

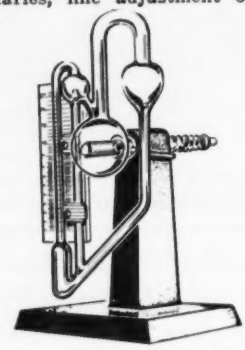
Differential-pressure Pickup

New "Model DP-7 Sensitive Pressure Transducer" is a reluctance type pickup for measurement of differential pressure of all non-corrosive gases and liquids, ranges from ±0.5 to ±15 psi. differential at line pressures up to 100 psi. Unit will withstand maximum line pressure in either direction. Applications include laboratory testing, radio telemetering and process control requiring precise measurement of flow differentials statically and dynamically. Absence of mechanical loading on pressure-sensing diaphragm results in a high natural frequency (1000 cps. for 1-psid. range). Output is derived from two inductances which vary 10 percent in opposite directions with application of full pressure. Unit will operate in a-c. carrier systems from 60 to above 10,000 cps. with an accuracy, including non-linearity and hysteresis effects, of 1 percent of full scale. When operated in a bridge circuit at 3 kc., full-scale output is ±50 mv./v. and maximum excitation is 50 v.—*North American Instruments, Inc.*, 2420 *N. Lake Ave., Altadena, Calif.*

For more information circle **210** on inquiry card.

Vacuum Gage

New "Lippincott McLeod Gage" is of quick-reading tilting type, with "Automatic Zero" feature assuring accuracy at all points without tedious manipulation of mercury. Accuracy is further assured by precision-bore capillaries, fine adjustment of bulb volume and precisely-graduated glass scale. Four sizes, with ranges to 1, 5, 10 and 15 mm.—*Kontes Glass Co., Vineland, N. J.*

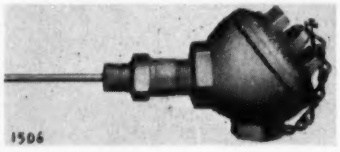


For more information circle **211** on inquiry card.

TEMPERATURE INSTRUMENTS and ACCESSORIES

Thermal Primary Element

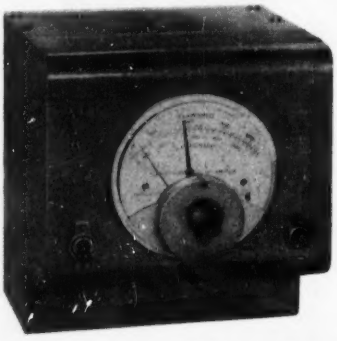
New "Model 166KC" is a tip-sensitive resistance-thermometer type primary element designed primarily as motor over-temperature detector; also suitable for temperature recording, indicating and monitoring systems. Available in lengths up to 4 ft.; max. diam. 0.218 in. Usable temperature range, –70 to 300 C.—*Instrument Div., Thomas A. Edison, Inc., West Orange, N. J.*



For more information circle **212** on inquiry card.

Indicating Pyrometer

New "Series 300" indicating pyrometer has 3-in. scale graduated in both F. and C. External adjusting screw sets compensation for room or ambient temperature. Instrument comes with Chromel-Alumel TC; is available in 0-1500, 0-2250 or 0-2500 F. ranges.—*Cybertronic Corp. of America*, 136 *8th St., Upland, Chester, Penna.*



For more information circle **213** on inquiry card.

1542

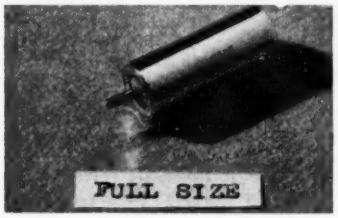
Tank Thermometer

New "Scoop-Master" features a one-piece cup case molded of a smooth heat-resistant plastic which is a non-sparking insulating material. This plastic's low thermal conductivity insures maintenance of sample temperature. Scale is engraved on a wide-bore tubing held by spring clips, replaced quickly without tools. Cup capacity, 120 ml, meets API and ASTM requirements. — *Weksler Thermometer Corp., 49 West 32nd St., New York 1, N. Y.*

For more information circle **214** on inquiry card.

Miniature Thermostat

New "VAL 90" miniature thermostat now operates with less than half former differential of 5 F.: 2 F. or



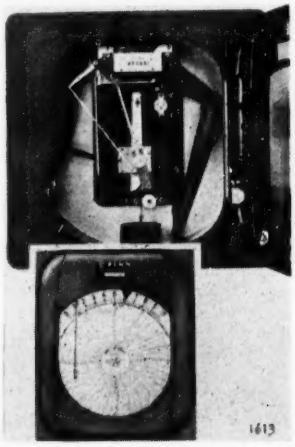
better, and without false contacting. Unit is laboratory adjusted for differential and for a setting tolerance of 3 F. or better; hermetically sealed and given a "life" run; then checked before release to user. Standard settings to 300 F., rating 30 v.-60 w., and 120 v.-100 w. a.c. and d.c.—*Valverde Labs., 252 Lafayette St., New York 12, N. Y.*

For more information circle **215** on inquiry card.

FLOW

Tilting U-tube Flowmeter

New model of maker's tilting U-tube mechanical flow meter has been given a "face-lifting" for adaptation to present-day panel instrumentation. Basic operating principle of a U-tube balance, said to be "still considered



1613

HOW CHATILLON ISO-ELASTIC* SPRINGS IMPROVE BENDIX's ECLIPSE-PIONEER FLOW-METERS

ECLIPSE - PIONEER
DIVISION OF BENDIX AVIATION CORPORATION
TETERBORO, NEW JERSEY

January 22, 1954

John Chatillon & Sons
85 Cliff Street
New York 38, New York

Attention: Mr. E. Gerard Fauquenot,
Director of Research & Development

Gentlemen:

As the world's largest manufacturer of precision aircraft instrument and accessory products, we are constantly challenged to build our products with a greater degree of accuracy and a higher factor of dependability over a continually widening set of environmental conditions. For example, at the conclusion of World War II it was sufficient that our Fuel Flowmeter Systems operate throughout a temperature range of -55° F. to 210° F. Today the same product must satisfactorily withstand an ambient temperature range of -65° F. to 475° F. and maintain a peak accuracy of 0.5% of full scale indication. That our Flowmeters are used almost exclusively on military aircraft and on nearly 80% of all commercial planes is answer in itself to the accuracy and reliability of the instrument.

As the supplier of one of the most critical parts in the Flowmeter — the calibration spring which controls the position of a vane against the flow of fuel in a metering chamber — you will be interested in knowing that your efforts have played an important part in the success of this equipment. Not only have your Iso-Elastic springs satisfied our general specifications but their temperature compensated qualities have enabled us to meet more stringent accuracy requirements throughout the wider temperature ranges.

We also want to express our appreciation for the excellent service afforded us on our latest Flowmeter job, and for the personal-type interest your engineers have always taken in working these problems out.

Very truly yours,
ECLIPSE-PIONEER DIVISION
BENDIX AVIATION CORPORATION
J. E. Berne
Chief Engineer
Mechanical Accessories

*U.S.A. Pat. No. 21174171

A few years ago, with the assistance of Professor A. V. DeForest of M.I.T. and Professor F. Sayre of Union College, John Chatillon & Sons developed a special nickel chromium alloy called "Iso-Elastic." Chatillon "Iso-Elastic" is a temperature-compensated material that is virtually unaffected by temperature changes and is used in most accurate force measuring devices. Other important characteristics of Chatillon "Iso-Elastic" which make it exceptionally valuable in the instrument field are a notable absence of hysteresis and drift errors. For these reasons, Chatillon "Iso-Elastic" has been used extensively in the aircraft, instrument and electronic fields.

Perhaps you can improve your instruments in the same manner as Eclipse-Pioneer. Contact Chatillon Spring Division for assistance in redesigning your present springs. Engineering bulletins on Chatillon "Iso-Elastic" alloy and springs are available on request.

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For more information circle **45** on inquiry card.

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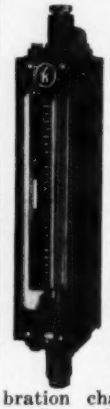
For more information circle **46** on inquiry card.

NEW INSTRUMENTS

the most powerful mechanical meter available," has not been changed dynamically or dimensionally. Instrument may be equipped with pneumatic transmitter which provides air output directly proportional to flow. Calibration can be quickly checked without disturbing pipe connections, and differential range may be altered at any time by changing cam weight. Manometer is made of welded steel suitable for 1000-psi. working pressure.—*Penn Industrial Instrument Corp.*, 4110 *Haverford Ave., Philadelphia 4, Pa.*

For more information circle **216** on inquiry card.

Flow-rate Indicator

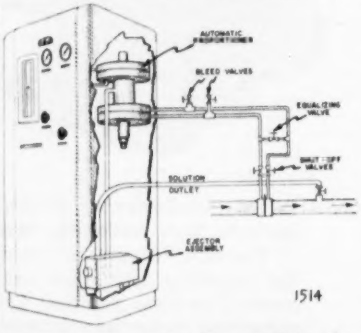


New "Safeguard Rotameter" features enclosed steel meter case with detachable safety glass windows, protecting metering tube from external shock and acting as a safeguard in event of accidental tube breakage. Standardized construction permits use of up to four sizes of meter tubes in one meter case; and variety of available rotor designs affords a wide range of capacities within one meter size. Scales are available calibrated either in units of flow, or in millimeters for use with calibration charts. "Safeguard Rotameter" can be adapted for electric or pneumatic transmission and remote recording of flow-rate.—*Schutte and Koerting Co., Cornwells Heights, Bucks County, Penna.*

For more information circle **217** on inquiry card.

Chlorinator Proportioner

New corrosion-resistant automatic proportioning component for chlorinators feeds chlorine to water or sewage lines in a direct and preset proportion to flow-rate. Two models: for standard and high-capacity chlorinators, available in two standard differential ranges: 0-50 in. and 0-100 in. water.—*Fischer & Porter Co.*, 20 *Jacksonville Rd., Hatboro, Penna.*

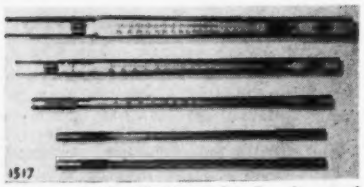


1514

For more information circle **218** on inquiry card.

Predictability Flowmeters

New line of "Predictability Flowmeters" is said to afford complete predictability of all fluids, obviating need of individual calibrations for



1517

each specific fluid: only density and viscosity of fluid under conditions of flow are required to be known. New Teflon stop provides quick interchangeability and ball replacement at no extra cost.—*Emil Greiner Co.*, 20 *N. Moore St., New York* 13, *N. Y.*

For more information circle **219** on inquiry card.

FORCE

1418

Kilogram Scales

New series of kilogram scales is added to maker's line of "Hydroscales." Models from 500 to 2,000 kg. are provided with 12-in. dials; from 3,000 to 50,000 kg. with optional 24-in. or 30-in. dials. —*Hydroway Scales, Inc.*, 20624 *W. 8 Mile Road, Detroit* 19, *Mich.*

For more information circle **220** on inquiry card.

Acceleration Pickups

New acceleration pickups are added to "Model A" announced two months ago: "Model BA" has aluminum case and mounting flange; connector entering side of case; weight 1.3 oz.; sensitivity 10 mv./*G* or better. ★"Model CA," lightest of new line, weighs ½ oz.; aluminum case with ¼-28 mounting stud and connector entering side of case; sensitivity 10 mv./*G* or better. ★"Model CS" is like "CA" but case is stainless steel. ★"Model DA" is 1 in. diam. and 1 in. high; has extraordinary sensitivity of 75 mv./*G*. —*VibraShock Corp.*, 6114 *River Rd., Washington* 16, *D. C.*

For more information circle **221** on inquiry card.

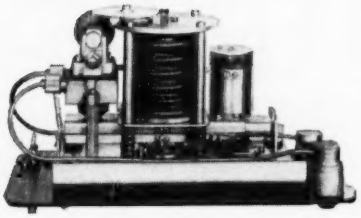
TIME

Time-operation Recorder

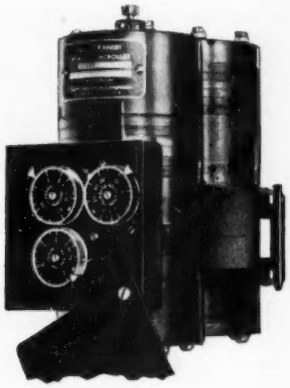
New "Model CSR Master Time Printer" is for use wherever printed confirmation of remote procedures, actions or methods is required, e.g., as a

1379

TRANSAIRE® to TRI-ACT® to TRANSET®



A



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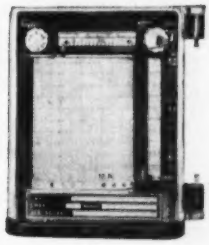
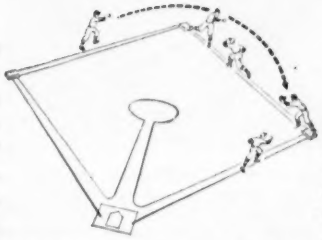


C

YOU DON'T HAVE TO WORRY ABOUT THIS TEAM EITHER!



The famous combination of Tinker to Evers to Chance could be relied upon for perfectly coordinated team work. The Taylor TRANSET System comprises three stars of the instrument world that work together to make the fastest, most dependable pneumatic transmission system.

YOU don't have to worry about the performance of the Taylor TRANSET System. And equally important, you don't have to worry about its maintenance, thanks to the exclusive TRANSET Plug-in feature and complete interchangeability of all receivers and controllers. Pull one instrument out—plug in another in seconds. It's that simple. Think what this means in terms of efficient, economical plant maintenance. Down time—and process interruption—is kept to the absolute minimum. Your instrument men can use their talents to maximum effect—and keep out of the operator's hair—because instruments can be taken to the shop for maintenance. And trouble, whether instrument or process, can be pin-pointed in the shortest possible time by simply plugging in a replacement unit of known performance.

Complete interchangeability of units is achieved by standardizing the output pressure range (3-15 psi) of transmitters, controllers and receivers. This means any controller and any receiver can be used with any (3-15 psi) transmitter. It also means a minimum stock of components.

The Taylor TRANSET System is truly the most versatile control system available today. Your Taylor Field Engineer will tell you how you can benefit from its features, or a post card will bring you **BULLETIN 98097.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

CHECK THESE ADVANTAGES:

1. You can plug in shop-adjusted instruments.

2. You can efficiently analyze process difficulties by quickly substituting a recorder for an indicator.

3. You can switch from the simplest to most complete controller in a matter of seconds.

4. Down time is kept to a minimum, since both controllers and receivers plug in.

5. Maintenance is unnecessary in the area of the panel. Checking can be done in the shop where full facilities are available.

6. One standard panel cut-out ($5\frac{1}{32}$" x $4\frac{5}{32}$") accommodates 12 different forms of recording and 11 different forms of indicating receivers.

7. You conserve panel space without impairing maintenance facilities.

8. Self-purging case for all receivers is especially appreciated in corrosive or dusty atmospheres.

9. Your plant can be kept running smoothly, without expensive shutdowns.

A. TRANSAIRE force-balance temperature or pressure transmitter. SPEED-ACT* gives rate action in the measuring circuit to compensate for process lags. Narrow range spans. Standard 3 to 15 psi output. Interchangeable unit construction. Temperature and Barometric Pressure Compensations.

B. TRI-ACT Controller. A force-balance controller with a new circuit . . . a new concept in process control. Booster relay air valve for faster response of control circuit. Wider response adjustments than ever before. Panel or locally mounted.

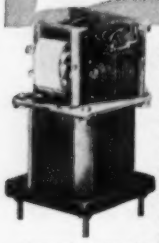
C. TRANSET Recorder. Fits 5 1/32" x 4 5/32" opening—a natural for graphic panels; a great space saver for conventional panels. Powerful actuation—bellows operated rectalinear movement. 30-day chart, 3-hour visible record. Everything needed for remote control.

*Reg. U. S. Pat. Off.

Taylor Instruments MEAN ACCURACY FIRST

For more information circle **47** on inquiry card.

STANDARD PACKAGED PUSH-PULL MAGNETIC AMPLIFIERS by MA



MAGNETIC AMPLIFIERS—These high gain, high performance Magnetic Amplifiers are especially suitable to drive two phase induction servo motors requiring from 0.1 watt to 20 watts per phase on either 400 cps or 60 cps powerlines. The output power is either in phase or 180 out of phase with the powerline depending on the D.C. input signal polarity.

DATA SHEETS AVAILABLE

STANDARD TUBELESS SERVO AMPLIFIERS with built-in adjustable SERVO LOOP STABILIZATION. Packaged, completely self-contained, magnetic servo amplifiers for position servo systems where either A.C. or D.C. error signals are available. Designed for instrument type and power type servo systems to work with synchro control transformers or potentiometers and two phase induction servo motors.

New Automatic Universal TRANSISTOR CURVE TRACER

USES—Designing transistor circuits — comparing, matching and selecting—detecting anomalies—studying effects of temperature, age, normal usage, over-loading—detecting failures and cause.

WRITE FOR COMPLETE INFORMATION

FEATURES

Tests NPN, PNP, Junction, Point Contact Transistors—flexible to accommodate new types. Dynamically plots entire family of curves simultaneously on standard laboratory DC oscilloscope. Function switch selects: output or transfer curve in grounded base or grounded emitter connection. Calibrating axis generated internally as integral part of display are always in correct quadrant.

MAGNETIC AMPLIFIERS • INC

An Affiliate of General Ceramics & Steatite Corp.

632 TINTON AVE., NEW YORK 55, N. Y.

Telephone CYPRESS 2-6610

For more information circle **48** on inquiry card.

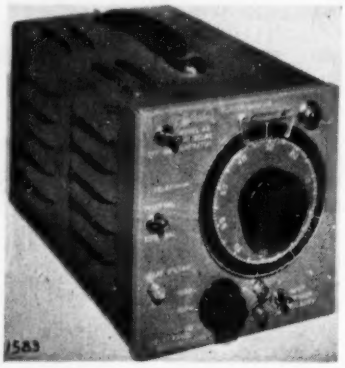
NEW INSTRUMENTS

central time study instrument in conjunction with machine tools. Whenever contacts are made at a remote station, it prints corresponding station symbol, time and date on a standard 2¼-in. paper tape. It has a capacity of 30 stations, and will automatically accept, monitor and record all station information regardless of simultaneous station operation or sequence.—*Cincinnati Time Recorder Co.*, 1733 *Central Ave., Cincinnati, Ohio.*

For more information circle **222** on inquiry card.

Time-delay Generator

New "Model A-5 Time Delay Generator" produces variable time delays from 1 to 1,000 microseconds in three



delay ranges: full-scale reading of 10 usec. delay on lowest range and progressing by decade steps to highest range of 1,000 usec. A blocking oscillator output is provided. Wide range of delays available, together with 0.1-percent accuracy, are said to make new unit especially useful in radar, computer, and pulse-technique fields for measuring unknown delays, generating a delay for simulation of radar range, providing delayed sweeps for synchroscopes, or measuring waveforms.—*Rutherford Electronics Co.*, 3707 *S. Robertson Blvd., Culver City, Calif.*

For more information circle **223** on inquiry card.

SPEED

A-c.-motor Speed Control

New "Speed Control" for fractional-hp. shaded-pole motors can be made for three-speed operation; features air-gap design which assures starting at low voltages and eliminates core saturation. Three models: (1) Cased control for remote-control installations; control reactor and switch mounted in an outlet box for permanent installation; knock-outs for wiring. (2) Panel-mounted to permit single-hole mounting on panels in certain applications. (3) Chassis mounted, convenient where desirable to mount control reactor within fan base or blower enclosure. Lead length can be provided to suit any application, and size of control varied to fit enclosure.—*Ballastran Corp.*, 1701 *North Calhoun St., Fort Wayne* 7, *Indiana.*

For more information circle **224** on inquiry card.

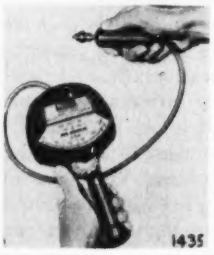
D-c.-motor Speed Control

New variable speed control for lathes and other machines powered by fractional and 1-hp. d-c. motors

accomplishes what step pulley drives do but much faster. To change speeds, control knob A is turned. D-c. supply B may be located where most convenient.—*Electro Products Labs.*, 4501 *N. Ravenswood Ave., Chicago* 40, *Ill.*

For more information circle **225** on inquiry card.

Hand Tachometer



New model of maker's hand tachometer has range selector which changes scale numbers for each range.—*Metron Instrument Co.*, 432 *Lincoln St., Denver* 3, *Colo.*

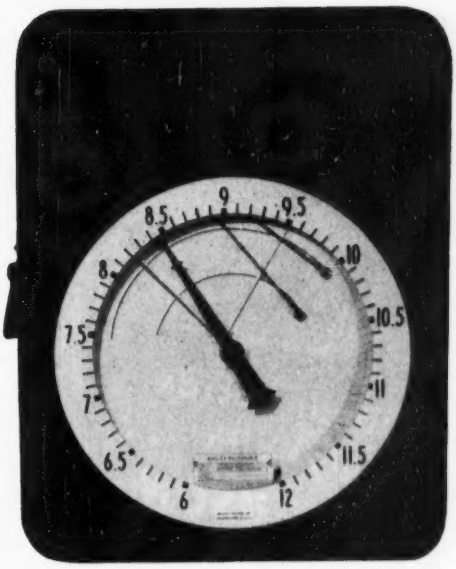
For more information circle **226** on inquiry card.

COUNTING

Intervalometers and Count Limiter

New "B-9A and B-10A Intervalometers" furnish a 28-v.dc., 3-amp. inductive pulse of 0.250-second duration, at regular time intervals which may be changed instantly by turning

PYROTRON
by BAILEY...



Your best buy for Precision Temperature Measurements In the -300F to 1200F Range

Check These Exclusive Bailey Advantages of Resistance Thermometer Operation

✓ Resistance thermometer operation over a complete range from –300F to 1200F has been made possible by Bailey's development of a low-cost platinum resistance element.

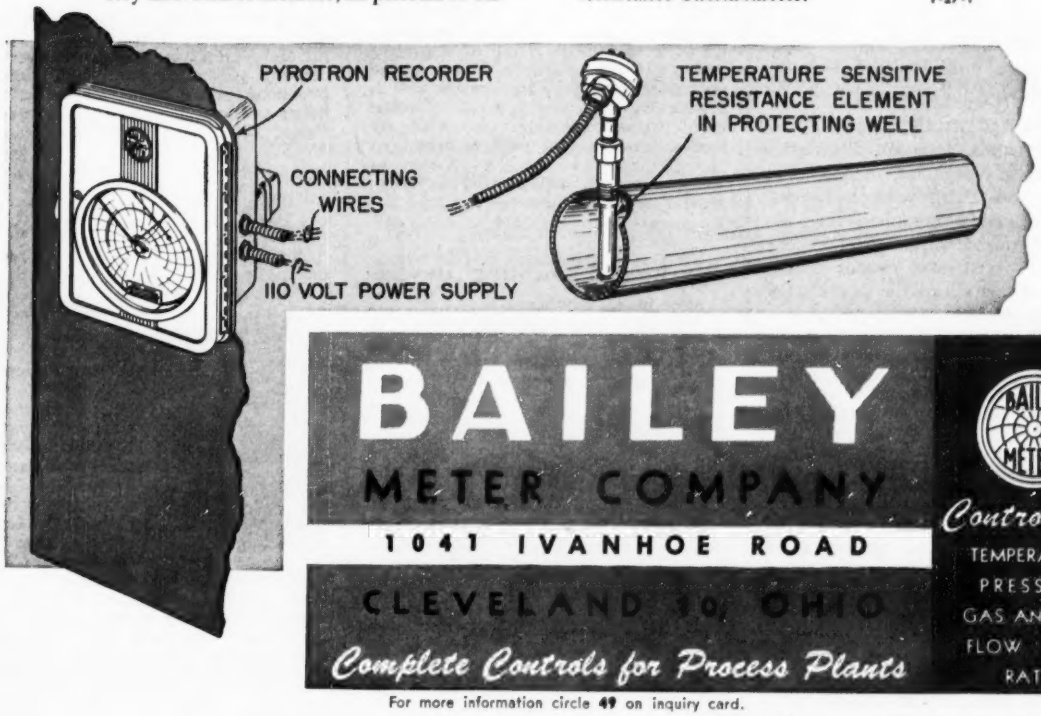
✓ Resistance thermometer operation requires no standard cell, dry battery and cold junction compensator. Uses 115 volt a-c source. Strong signal and high precision of resistance element as compared to thermocouple makes possible the use of narrow range spans.

✓ The Bailey Pyrotron is calibrated at the factory and *remains* accurate; no periodic re-calibrations required. Since all elements are matched it is not necessary to calibrate each recorder to its element.

✓ Recorder is sensitive to 1/10 of 1% of range span.

✓ Ordinary copper lead wires permit remote location of recorder with respect to the temperature sensing element.

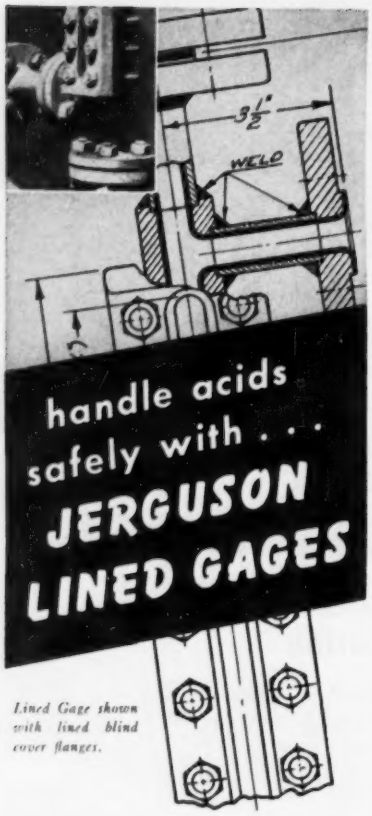
✓ For complete information, write for bulletin 230-C on the Bailey Pyrotron Electronic Resistance Thermometer. P-27-1



BAILEY METER COMPANY
1041 IVANHOE ROAD
CLEVELAND 10, OHIO
Complete Controls for Process Plants

BAILEY METERS
Controls for
TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW LEVEL
RATIO

For more information circle 49 on inquiry card.



Lined Gage shown with lined blind cover flanges.

WHERE concentration of liquids such as sulphuric, muriatic or other acids necessitates equipment with special linings, Jerguson can furnish you with reflex or transparent gages lined with natural and synthetic rubbers, lead, phenolic base compounds, Teflon, and other materials. Jerguson Lined Gages are designed to meet your requirements of long-life and dependable operation.

To meet your constantly increasing variety of demands, Jerguson engineers, working closely with the men in the Chemical and Petrochemical Fields, have developed a complete line of sound, dependable liquid level gages, valves, and specialties in various metals and synthetics to handle corrosive liquids and gases.

Jerguson Gages keep you out of trouble, and they save you time and money. Send for drawing GD-431 on Lined Gages, or send your requirements.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Fellsway, Somerville 45, Mass.
Offices in Major Cities
Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

For more information circle **50** on inquiry card.

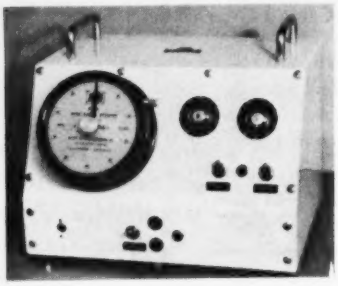
NEW INSTRUMENTS

dial to interval desired. Repeat accuracy of pulse interval is within 10 milliseconds over a supply voltage range of 24 to 29 v.dc. Provision is made to start and stop Intervalometer from a remote position. Each model is provided with two interchangeable time interval scales providing, in all, four ranges to 12, 24, 60 and 120 seconds in 0.1, 0.2, 0.5, and 1-sec. increments. ★New "CN-1A1" Count Limiter may be used for stopping Intervalometer at desired number of pulses from 1 to 120. Two Count Limiters may be connected together to provide control up to 14,400 pulses. Any number of Intervalometers and Limiters may be interconnected to provide an infinite variety of pre-set pulse programs.—*Dep't S15, Abrams Instrument Corp., 606 E. Shiawassee St., Lansing 1, Mich.*

For more information circle **227** on inquiry card.

Electronic Counter

New "D.W.A. Electronic Counter" (English-made) counts positive or negative electrical pulses at rates up

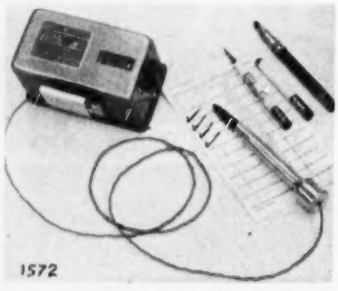


to 5,000 per second; consists of two "Dekatron" counter tubes feeding a high-speed electromechanical register, with necessary power supplies and driver stages. Tubes indicate units and tens; register indicates hundreds; up to a maximum count of one hundred million pulses. Front panel switch starts and stops count and a spring-loaded switch resets "Dekatron" tubes. Register is reset by knobs. Input socket accepts standard ¼-inch coaxial cable—*American Tradair Corp., 405 Lexington Ave., New York 17, N. Y.*

For more information circle **228** on inquiry card.

Marking-&-counting Device

New model of "Mark-N-Count" has a belt clip, which allows counter to be carried to counting job. Available for all models is pencil, rubber stamp, chalk or grease pencil, or lead holding



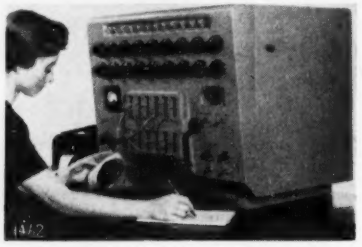
chuck. Another insertable tool has a rubber tip, is used for counting sheets of paper. A tool used in materials handling work fits on third finger, cord is run up sleeve, and ring contains a Microswitch and marking device. It is possible to move packages all day long while accurately counting and marking them.—*May Engineering Co., 6055 Lankershim Blvd., N. Hollywood, Calif.*

For more information circle **229** on inquiry card.

COMPUTING

Desk-top Computer

New "REAC Models C301 and C302" are said to "replace conventional computing equipment that nor-



mally occupies a seven-foot cabinet," can solve differential equations, or simulate physical systems, up to sixth order of magnitude. All mathematical operations are performed with better than 0.1 percent accuracy. Problems are set up on patch boards which plug into front, so that one computer can be used for several problems and by different operators in succession with minimum set-up time. "REAC C301" has all components wired directly to patch bay, affording utmost flexibility. Problem control is obtained by patching computing elements through switches and relays. "REAC C302," has a completely integrated built-in problem control system, so that patching for industrial and research laboratory and office, and operating of problems is the same as in maker's large computers.—*Reeves Instrument Corp., 215 E. 91 St., New York 28, N. Y.*

For more information circle **230** on inquiry card.

Computer Power Supply

New "Type C Stablvolt" is said to be the first magnetic regulated d-c. power supply that "can be used as a d-c. power source for digital and analogue computers to provide the extremely precise regulation and the very low internal impedance which is required." It is a doubly magnetically regulated supply, whose internal impedance is extremely low (in many applications mainly determined by cable impedance between power supply and load) and decreases with increasing load frequency. Response to both a-c. line voltage and d-c. load variations is

Ham on Rye or Rye on Hand?

Count BOTH

(and 1,001 Other Items)

with this New Veeder-Root

VARY-TALLY

Multiple-Unit Reset Counter

Knowing how many apple versus lemon pies, for instance, are ordered on a given day . . . or how many cases of what are in the cellar . . . helps a restaurant *count*rol, make plans, make profits. The same goes for a manufacturer or wholesaler seeking tighter inventory control . . . or for any of the following:

- Traffic Engineers
- Schools and Colleges
- Nurserymen and Florists
- State Park and Forest Services
- Laboratories
- Milk Plants and Ice Cream Processors
- Researchers
- Industrial Plants
- Textile Mills
- Inspection and Quality Control
- Jobbers, Wholesalers, Distributors
- Restaurants and Hotels
- Mail and Phone Order Departments
- Laundries and Linen Supply Houses
- Manufacturers of equipment for:
  - Order Control
  - Stock Control
  - Inventory Control
  - Traffic Control
  - Sales and Market Analysis
  - Laboratory Analysis
  - Payroll Preparation
- and What Do You Want to Count?

Arranged compactly on stands in tiers, the Vary-Tally can be supplied in any of 66 combinations, up to 6 banks high and 12 units wide, with a minimum of 2 units wide. Write for news sheet and prices.

"The Name that Counts"

VEEDER-ROOT INC.

HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C. • Montreal 2, Canada • Dundee, Scotland • Offices and Agents in Principal Cities

For more information circle 51 on inquiry card.

A new concept in Temperature Monitoring!

KYBERNETES

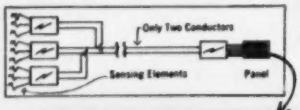
ELECTRONIC SWITCHES

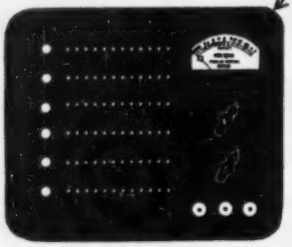
NOW *replace* Multiple Conductor Cables or Mechanical Scanning

WITH—

ELECTRONIC SCANNING

Completely Non-Mechanical and utilizing only two conductors.





PANEL SIZE MINIMIZED

Zone alarm lights. Point alarm lights. Meter for direct temperature reading. Zone switch. Indicator lamp test button. Reset button. Point switch. Horn turn off.

Features:

LOWEST INSTALLATION COST
- Utilizes inexpensive RG-59/U coaxial cable instead of 200 conductors in an average installation of 100 points.

COMPLETE INFORMATION AT PANEL BOARD
- Zone and point alarms.
- Point temperature readings.
- Uninterrupted scanning and alarm indication during temperature reading.

SELF MONITORING
- Alarm and meter indicate failure of any circuit element.

NOW BEING DEMONSTRATED

Write for Specifications 3

THE

KYBERNETES

CORPORATION

1102 RAYMOND BOULEVARD

NEWARK 5, N. J.

division of SELF WINDING CLOCK COMPANY, INC.

For more information circle **52** on inquiry card.

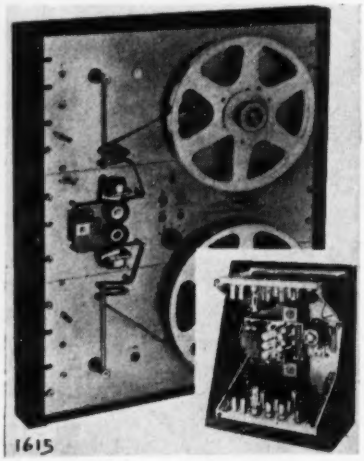
NEW INSTRUMENTS

practically instantaneous. Dynamic regulation is better than 0.1 percent for step change of a-c. line voltage from 95 to 135 and better than 0.1 percent for line frequency variations from 57 to 63 cps. Zero- to full-load static regulation is better than 0.15 percent and dynamic regulation is better than 0.2 percent for step change of 20 percent in d-c. load current. Ratings from 1.5 to 500 volts and 1 to 100 amps. d-c. output.—*Magnetic Research Corp.*, 318 *Kansas St., El Segundo, Calif.*

For more information circle **231** on inquiry card.

Digital Tape Handlers

New "Model 902 Digital Tape Handlers" meet requirements for digital recording equipment with start and stop times of 5 milliseconds and tape



speeds up to 60 ips. Extension of available tape width to ⅝ in. permits up to 8 channels of information to be recorded simultaneously. Interchangeability: tapes recorded on one tape handler can be played back on another. Other features: Servo-controlled reel drive systems ensure low tape tensions in spite of high acceleration and deceleration. Head-azimuth adjustment. Choice of 30/15 and 60/15 ips. with ¼, ½ and ⅝-in. tape to provide maximum versatility. All models equipped with standard NAB hubs. Versions available for handling teletype tape. —*Potter Instrument Co., Inc.*, 115 *Cutter Mill Rd., Great Neck, N. Y.*

For more information circle **232** on inquiry card.

Pentode for Computers

New "6197" is a sharp-cutoff pentode of 9-pin miniature type having extremely high transconductance, designed especially for frequency-divider and pulse amplifier circuits in electronic computers and other "on-off" control applications involving long periods of operation under cutoff conditions. It is said to maintain its emission capabilities even after long periods of operation under cutoff conditions, and to supply a high minimum value of plate current during its "on" cycles.—*Tube Dep't, Radio Corporation of America, Harrison, N. J.*

For more information circle **233** on inquiry card.

PHOTOGRAPHY, Etc.

Reflex Camera

New "Contaflex" single-lens reflex camera for 35mm film differs from prewar twin-lens mirror-reflex camera of same name. Viewing screen embodies both ground-glass and range-finder focusing. Lens is Tessar f/2.8, 45mm. focal length. Synchro Compur (MX) shutter has flash and strobe synchronization built in for all speeds from 1 to 1/500th sec. Among other features: removable back for film loading and cleaning; takes both 35mm. film cartridges and Contax film cassettes; automatic lens diaphragm setting mechanism permits focusing with lens wide open (when shutter release button is pressed, diaphragm closes to stop value for which it was pre-set); objects as close as 10 in. may be photographed with assurance.—*Carl Zeiss, Inc.*, 485 *Fifth Ave., New York* 17, *N. Y.*

For more information circle **234** on inquiry card.

Photocopy Papers

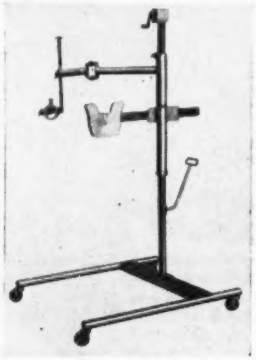
New slow-speed "Dri-Stat No. 1" (negative) paper is said to make possible office photocopying "in four to five times brighter light than has been possible with any papers previously available." Photocopies can be made under fluorescent or incandescent light of fairly high intensity or in subdued daylight; results are as sharp and clear as those obtained under more favorable conditions with standard-speed No. 1 and similar papers supplied by other dry-process manufacturers. ★"Dri-Stat No. 2" (positive) paper is now available in three different types: in addition to "Standard" 95-gram paper, "Duplex" paper coated on both sides, and lightweight "Thin" paper.—*Dri-Stat Div., Peerless Photo Products, Inc., Shoreham, L. I., N. Y.*

For more information circle **235** on inquiry card.

NUCLEONICS

Mobile Counter Holder

New "Mark 8 Model 82 Mobile Adjustable Radioisotope Counter Holder" provides a safe, convenient sup-



port for counter and shield used in measurements of radioactivity in hospitals, etc.; e.g. determination of I-131 uptake by thyroid.—*Radiation Counter Laboratories, Inc., Skokie, Ill.*

For more information circle **236** on inquiry card.

Shielded Isotope Carrier

New "Model 3035E" shielded carrier for handling bottled radioactive isotopes features a key-operated locking mechanism to prevent unauthorized personnel from handling isotope. A bottle containing a radioactive isotope may be lowered into "well" of shield, where it is surrounded by 1 in. of lead. A spring platform raises bottle so that it may be easily lifted out when lock is removed. Shield weighs 20 lbs., has a chrome-plated handle.—*Nuclear Instrument and Chemical Corp.*, 229 *W. Erie St., Chicago* 10, *Ill.*

For more information circle **237** on inquiry card.

Jacketed Counter

New "Mark 1 Model 71" thin-glass-wall jacketed Geiger counter is for monitoring radioactivity where continuous flow is involved, as in engine wear studies. Total length, 7½ in.; active anode length, 3 in., operating threshold, 800 to 1000 volts; window thickness 30 mg/cm². —*Radiation Counter Laboratories, Inc., Skokie, Ill.*

For more information circle **238** on inquiry card.

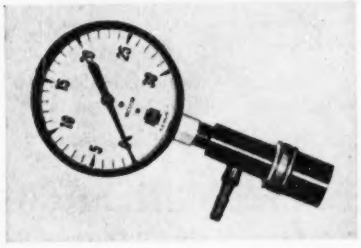
Radiocarbon Compounds

Nine new radiocarbon compounds make a total of 94 carbon-14 compounds available from undersigned company. New compounds include maleic-1-C^{14} anhydride, an important synthetic intermediate which forms polymers with many compounds; succinic-1-C^{14} acid and fumaric-1-C^{14} acid, intermediates in several biological cycles; phenylacetic-1-C^{14} acid, useful in amino acid metabolism. Five are C^{14} labelled fats, fatty acids, or derivatives.—*Nuclear Instrument and Chemical Corp., 229 W. Erie St., Chicago* 10, *Ill.*

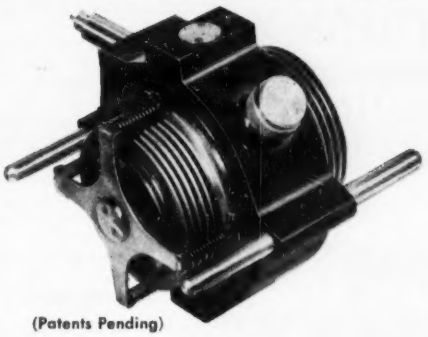
For more information circle **239** on inquiry card.

Air Sampler

New "BI-101 Radioactivity Laboratory Air Sampler," for use with nearly any radioactivity laboratory vacuum system or small vacuum



IIC flow meters



(Patents Pending)

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1. Greater power, longer-calibrated travel for assured accuracy.
2. One-piece seamless, type 316 stainless steel bellows. No pitting, no welds, longer life. (Monel bellows can be furnished for special services.)
3. An exclusive I.I.C. development, the patented free floating Non-Freezing Instrument Bearing, makes possible a new era in flow meter accuracy.
4. Differential obtained from actual displacement of fluid and not from stem movement.
5. Over-range protection to housing rating.
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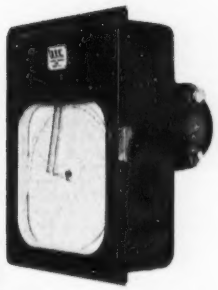
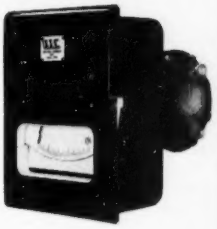
7. Complete compensation for wide range of ambient temperatures.
8. All standard ranges available: 0-10" H_2O to 0-300" H_2O.
9. Working pressures up to 5,000 psi.
10. No precise leveling required.
11. Self-draining. No seal pots required.

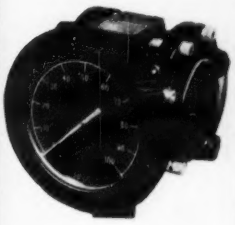


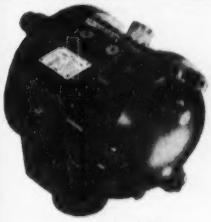
Model 802 Recorder
(Patents Pending)
IIC Model 802 Recording Flow Meter is actuated by Model 700 Meter Unit.
Simple installation. Built by experienced instrument men from a simple design, engineered for rugged duty.



Model 800 Indicator
(Patents Pending)
IIC Model 800 Indicator is actuated by Model 700 Meter Unit, is calibrated in same manner as Model 802 Recorder.

Model 800-6 Indicator
(Patents Pending)
IIC Model 800-6 Indicator is actuated by Model 700 Meter Unit. Standard 6" dials available in uniform, square root, as well as other special ranges.





Model 700 Meter Unit
(Patents Pending)
The new standard of quality for metering devices, the Model 700 Meter Unit is used by other instrument manufacturers to actuate their own differential pressure recorders, indicators, controllers and transmitters.

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For more information circle **53** on inquiry card.

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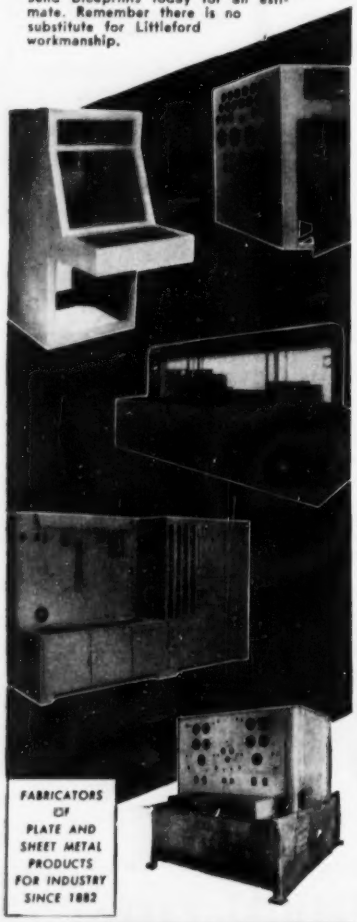

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404 E. Pearl Street, Cincinnati 2, Ohio

For more information circle **54** on inquiry card.

NEW INSTRUMENTS

pump, comprises a stainless-steel filter holder, vacuum gage and vacuum hose attachment. Holder takes 22-mm. diameter filter paper which later can be mounted directly on maker's standard 1-in. planchet for counting. Vacuum reading of 16 in. Hg indicates a flow rate of 4 scfm.—*Tracerlab, Inc., 130 High St., Boston 10, Mass.*

For more information circle **240** on inquiry card.

AIR and MARINE

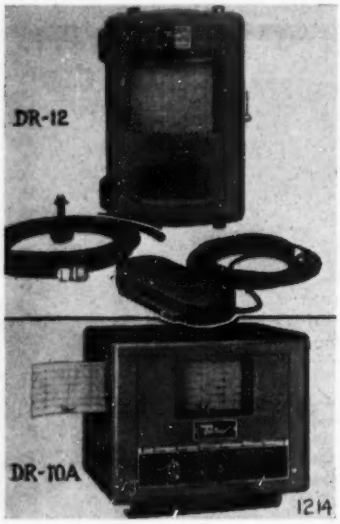
Radar Altimeter

New radar altimeter keeps pilot informed at all time of his height above surface of earth (not sea-level); was developed under contract with USN's BuAer., is said to represent a 10-year advance in use of radar for measuring altitude; functions reliably from a few inches off ground to limit of preset range; gives instantaneous altitude indication without instrument lag. Errors are said to be almost impossible: If device picks up a false or misleading signal, indicator needle is automatically hidden from view temporarily; when system has found a true reading again, needle becomes visible. This rules out errors caused by a faulty receiving tube, a weak transmitted signal, radio interference, etc. Total weight approx. 30 lbs.—*Raytheon Mfg. Co., Waltham 54, Mass.*

For more information circle **241** on inquiry card.

Marine Depth Recorders

Two new models are added to maker's line of depth recorders: "DR-12" has a 2-stage recording feature of 0-50 and 0-200 fathoms; incorporates a



new dual guide scan stylus said to produce extremely accurate recordings. ★"DR-10A" is a low-cost instrument with a new 3-stage range, recording up to 75 fathoms; can also be used with maker's "Flashing Indicator"; can be installed by owner without drilling through hull.—*Pacific Div., Bendix Aviation Corp., 11600 Sherman Way, N. Hollywood, Calif.*

For more information circle **242** on inquiry card.

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Every Size-for Every Service

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- Double Gland-Packed
- High Pressure

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For more information circle **55** on inquiry card.

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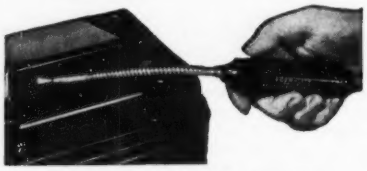
SPEEDS INSPECTION OF



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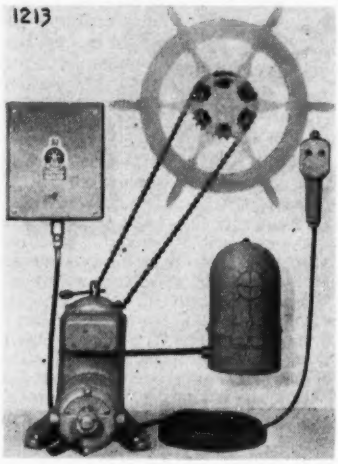
EDER INSTRUMENT CO.

2293 N. Clybourn St. (Dept. I) Chicago 14, Ill.

For more information circle **56** on inquiry card.

Marine Automatic Pilot

New "Model 125" automatic pilot, developed especially for small-boat owner, incorporates all of maker's fea-



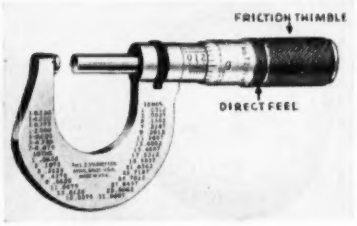
tures, including photoelectric principle and "a more powerful steering unit for accurate control under all conditions." It is available, at extra cost, with Remote Control Course Changer, Dodger and Power Steering.—*Pacific Div., Bendix Aviation Corp., 11600 Sherman Way, N. Hollywood, Calif.*

For more information circle **243** on inquiry card.

FOR INSTRUMENT SHOP

Friction-thimble Micrometer

New "Satin Chrome" micrometer caliper has built-in friction control mechanism plus direct feel. Among



twelve features: no-glare "Satin Chrome" finish; one-piece spindle; replaceable adjustable sleeve; quick-reading figures and tapered frame.—*L. S. Starrett Co., Athol, Mass.*

For more information circle **244** on inquiry card.

Smallest Torque Wrench

New "Standard Model F80-I-G" torque wrench, 0 to 80 inch-gram range is believed to be the lowest-capacity instrument of this type. It

Your Present On-Off Controller plus TRU-TEMP INPUT CONTROLLER

maintains furnace temperatures within ±0.2°F

Now you can get *laboratory* temperature control with your present industrial thermo-couples. A TRU-TEMP INPUT CONTROLLER, inserted into your present furnace control system, will keep your heat equipment within a fraction of a degree of the control point . . . automatically.

You need add no extra heating equipment or elaborate systems to secure this finer heat control. TRU-TEMP works by shifting your control point dynamically. It actually anticipates and prevents overshooting. Thus it stops the usual effect of thermal lag before it can occur. Your heat equipment reaches temperature stability and stays there . . . with complete elimination of undesirable "hunting", common to even the best unassisted on-off control systems.

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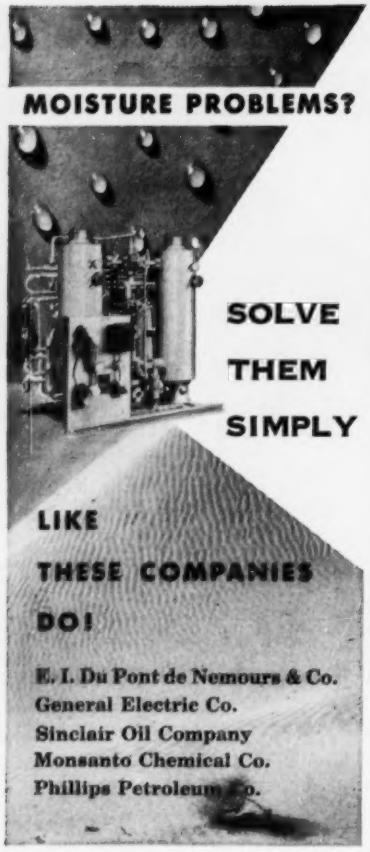

. . . and dozens and dozens more of the country's leading firms, technological schools, the armed services, the U. S. Atomic Energy Commission . . . *all* choose Pritchard HYDRYERS* for efficient, dependable dehydration of compressed air and other gases for instrument and process controls.

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For more information circle **58** on inquiry card.

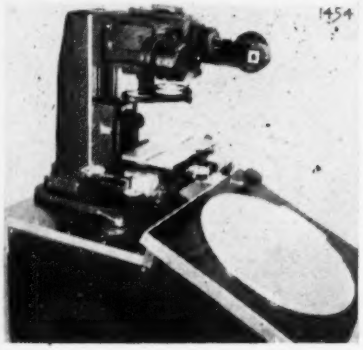
NEW INSTRUMENTS

may be handled as any ordinary small tool, yet is guaranteed to remain accurate over its life. Scale divisions are 5 inch-grams. Other models are available in same style in ranges 0 to 8 inch-ounces and 0 to 16 inch-ounces. —*P. A. Sturtevant Co., Addison, Ill.*

For more information circle **245** on inquiry card.

Optical Comparator

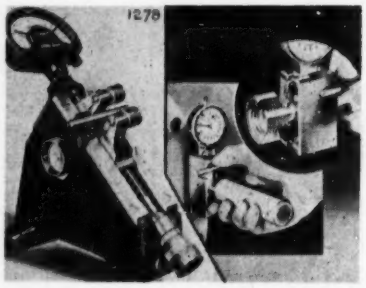
New "Model R-300" features maker's "Multi-Phase" optical system which projects an upright properly-oriented image with exceptional definition and screen brightness and provides exceptionally large working space clearance between lenses and object stage platform. New lens-mounting capstan permits instant change of magnification.—*Portman Instrument Co., Town Dock Rd., New Rochelle, N. Y.*



For more information circle **246** on inquiry card.

Indicating Thread Gages

New line of indicating thread gages comprises "Roller Thread Pitch Diameter Comparator Gage" (left) and "Dial Thread Plug Gage" for checking internal threads (right). Both are designed for quick inspection by unskilled operators. Errors due to unequal pressure and "feel" are eliminated—*George Scherr Co., 200 Lafayette St., New York 12, N. Y.*



For more information circle **247** on inquiry card.

Granite Straight Edges

New line of commercial-accuracy black-granite straight edges in lengths up to 72 in. supplements maker's "super precision" straight edges. Surfaces of units are finished to 0.0002 in. per foot. Same advantages as regular line.—*Collins Microflat Co., 2326 E. 8th St., Los Angeles, Calif.*

For more information circle **248** on inquiry card.

Dial Gages, Comparator

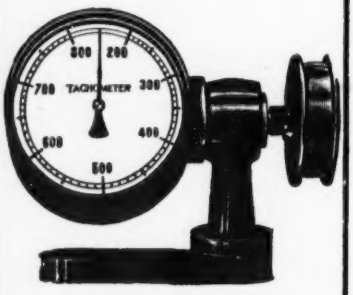
New "Millimess" dial-indicating gage may be built into machinery, fixtures, comparators, etc.; is shockproof; is provided with an extra lift of 5/32 in. whereby damage by oversize work is prevented. Replacement of usual lifting lever by a cable release, which lifts contact point by remote control, eliminates effects of hand temperature, unequal pressure and vibration. Outside zero adjustment and outside setting of tolerance hands are time-saving conveniences. "Model A" reads in 0.0005 in. with a range of 0.020 in.; "Model B" reads in 0.0001 in. with a range of 0.004 in. ★Either model can be furnished with a stand (as illustrated) making a ready-to-use comparator under trade name "Compar-It"; 2-in. table diameter; 2-in. distance from contact point to column; and 4½-in. vertical capacity.—*George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.*

For more information circle **249** on inquiry card.

Dial Indicator

New "Gem Dial Indicator #222" is said to provide "true, constant, repeat readings regardless of direction even under adverse conditions when there is outside vibration" Spirals are manufactured with an exclusive grinding process and a plating and

Amthor



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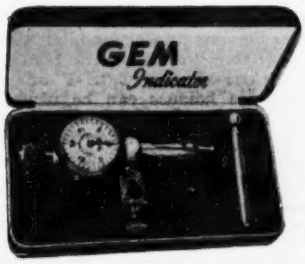
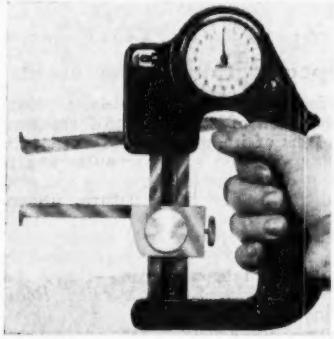


polishing to prevent sticky and jumpy readings. It is said that this feature is "not duplicated in any other indicator."—*Hairspring Vibrating Co., 406 32nd St., Union City, N. J.*

For more information circle **250** on inquiry card.

I. D. Dial-indicator

New "Model A Diametrick" inside-diameter dial-indicator-type measuring instrument checks holes from

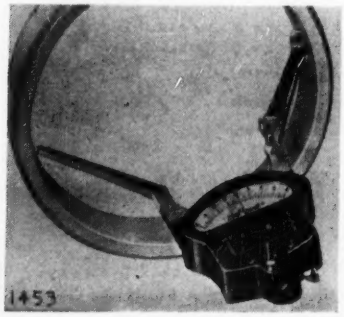


1.375 in. to 3.625 in. in diameter and expands to measure grooves as deep as ¼ in. Other sizes are available for smaller and larger bores. Among features: "feel" replaced by indicator readings; easily set to masters, gage blocks, micrometers and snap gages; all bearings and adjustments are outside of work. In use it is held with lower gaging arm resting firmly in work, permitting rocking of upper arm in all directions.—*Mutual Engineering Service, 402 Court St., Saginaw, Mich.*

For more information circle **251** on inquiry card.

I. D. Dial Indicator

New "Interapid Internal Comparator" measures inside dimensions from ⅜ in. to 6 in., reads directly to 0.0005 in. Initial setting is made with gage blocks, master gage rings or micrometers. A small locking lever (top center of photo) retracts arms to make it easier for gaging tips to



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There's a Shallcross Bridge for measuring resistance to any desired precision—indoors or out. Field models have aluminum cases with controls easily adjustable even with a gloved hand. Models for lab, production, and school use feature high readability and simple operation—even for unskilled users.

Accuracy, Stability, and Ruggedness—unsurpassed in any instrument of comparable price.

Selections from the complete Shallcross line are described below. Additional specifications on these, and many other types, are available from SHALLCROSS MFG. CO., 510 Pusey Ave., Collingdale, Pa.

Deliveries from Stock ✓

WHEATSTONE—FAULT LOCATION BRIDGE No. 6100: 5-dial field model. Locates grounds, crosses, opens, and shorts by Murray, Varley, Hilborn, or Fisher Loop and Capacitance tests. Range: 1 to 1,011,000 ohms. Accuracy: ± 0.1%, + 0.01 ohm. 8⅞" x 7⅜" x 5¾". 8 lbs. *Price: $175.*

KELVIN-WHEATSTONE BRIDGE No. 638-R: Shallcross has pioneered this compact combination of two bridges in one. Range: 0.001 to 11,110,000 ohms. Accuracy: ± 0.3% − 1 to 111,100 ohms. 12½" x 10½" x 6¾". 9 lbs. *Price: $260.* ✓

WHEATSTONE-LIMIT BRIDGE No. 6320: Combines 5-dial Wheatstone and Percent-Limit features. Range: 0.1 to 111,110,000 ohms. Accuracy—*Ratio resistors:* ±.01%, *Rheostat:* ±(.01% to .05% + .005 ohms). 15¾" x 9¼" x 5½". 15 lbs. *Price: $700.*

Shallcross

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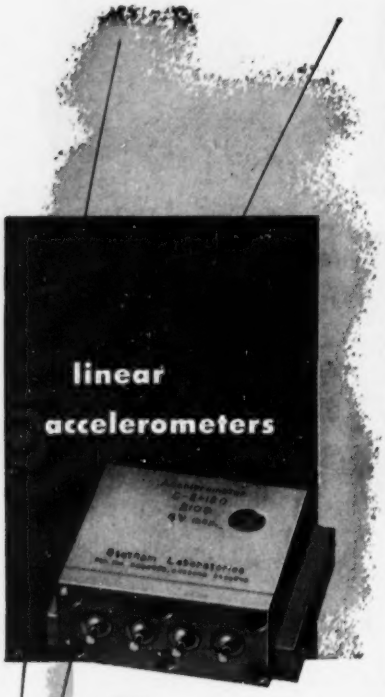
For more information circle **60** on inquiry card.



Linear accelerometers are manufactured by Statham Laboratories for measurement in ranges from ±0.5g to ±1,000g. Unbonded strain gage accelerometers have higher natural frequency than is usually attainable with other types of pickoffs. For maximum possible output, the mechanical construction of these instruments is such that movement of the suspended mass produces a change of resistance of all four arms of the complete balanced bridge. The resistive nature of the bridge permits the use of these accelerometers in either A.C. or D.C. circuits.

Please request Bulletin No. 4.0.

Statham LABORATORIES
• Los Angeles 64, Calif.

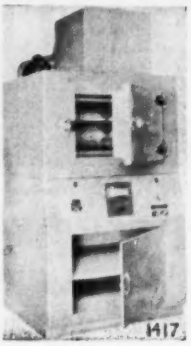
For more information circle **61** on inquiry card.

NEW INSTRUMENTS

enter work being checked. Measuring tips being at extreme end of arms, it is possible to check diameter of shallow counterbores. Set includes two sizes of centering arms which snap on and off readily, are used in checking larger diameters, provide a three-point contact on one arm which eliminates "hunting" for center of bore.—*The Portage Double Quick Tool Co., 1082 Sweitzer Avenue, Akron, Ohio.*

For more information circle **252** on inquiry card.

Electric Box-type Furnaces

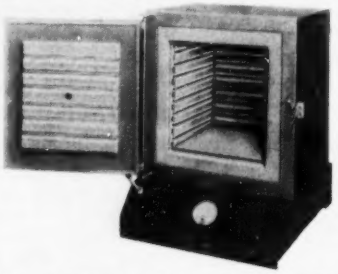


New electric box type recirculating furnaces are built in nine sizes and two temperature ranges, 0-800 F. and 0-1250 F. New skirt type cabinet, furnished complete with "Infitrol," indicating temperature controller, contactor, and switch box.—*K. H. Huppert Co., 6830 S. Cottage Grove Ave., Chicago 37, Ill.*

For more information circle **253** on inquiry card.

Electric Furnaces

New "Dyna-trol" electric furnaces, up to 2,000 F. and 2,300 F. reproduce any time-temperature curve within

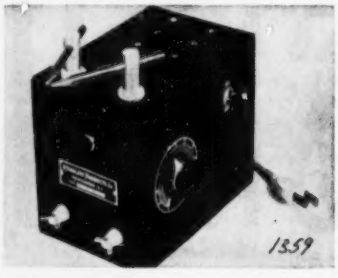


plus or minus 3 F.; are stable enough for calibration and instrumentation uses. New line consists of over 40 standard models; special models also available.—*L & L Mfg. Co., Chester 48, Penna.*

For more information circle **254** on inquiry card.

Soldering Unit

New "Model J-5" is designed for production soldering of contacts, pigtails, receptacles, AN connectors, springs, lugs, wire harness, instrument parts, cable assemblies, etc. Timing attachments and groundplates are also available for this unit. Binding posts for use of maker's "H-1" or "H-2" electrode holders can be used to make this unit more practical.—*Vemaline Products Co., P. O. Box 222, Hawthorne, N. J.*



For more information circle **255** on inquiry card.

FOR THE LABORATORY

Pipette Control

New "Micropet" pipette control, for use with any size pipette, eliminates accidental imbibing of infectious or toxic liquids; delivers accurately controlled volumes to 0.01 ml.; weighs 3 oz.; will withstand repeated autoclaving, being fabricated from anodized aluminum and corrosion-resistant materials.—*National Instrument Co., 5005 Queensbury Ave., Baltimore, Md.*

For more information circle **256** on inquiry card.

Spectrographic Pin Molds

New spectroshell molds permit production of standard uniform sample pins of improved homogeneity for better emission spectrographic analysis. Pin samples thus derived are generally superior in structure, unusually free from fins and sharp edges. Single unit spectroshell molds measure 2 x 4 x 3½ in. over-all, capacity 4 pins each ¼ x 2¼ in.—*Baird Associates, Inc., 33 University Road, Cambridge 38, Mass.*

For more information circle **257** on inquiry card.

HARDNESS TESTING...

done WITH NO MENTAL HAZARDS. The SCLEROSCOPE has done it for the past 47 years.

In general use for specification purposes. Simple, sturdy Comparatively inexpensive.

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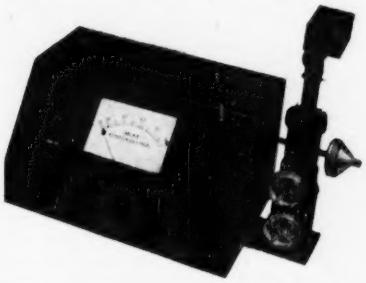
The Shore Instrument & Mfg. Co., Inc.

90-35 Van Wyck Expressway Jamaica 35, N. Y.

For more information circle **62** on inquiry card.

Smoke Photometer

New "Sinclair-Phoenix Smoke Photometer," for measurement of mass concentration (dust load) of particulate matter in atmosphere, is said to



achieve extreme sensitivity by use of forward-scattering method. Range is about 100,000, obtained on a single scale by logarithmic amplification. Each instrument comes with its individual standard calibration curve; an additional calibration for a range of about 3000 is obtainable. Molecular filter type collector facilitates examination of samples.—*Phoenix Precision Instrument Co.*, 3803 *N. 5th St., Philadelphia* 40, *Pa.*

For more information circle **258** on inquiry card.

Lab Dry-ice Pulverizer

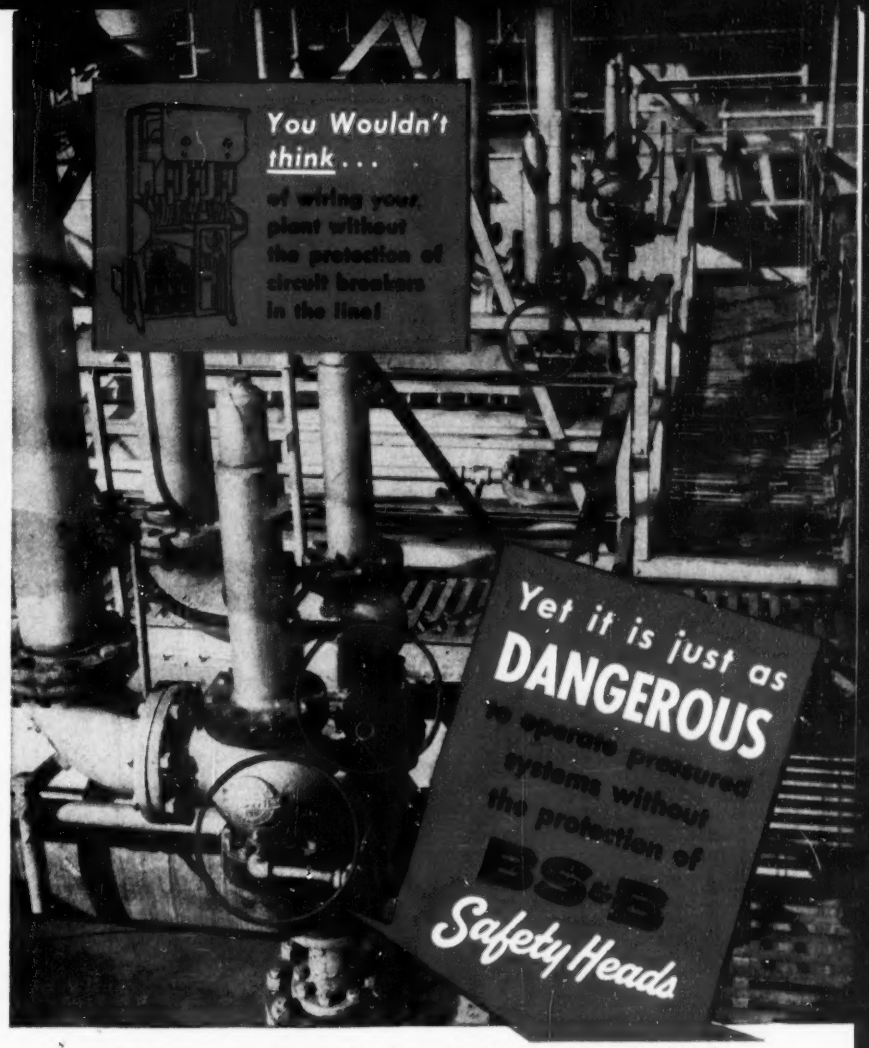
New "Supreme" laboratory-size dry ice pulverizer makes 100-percent powdered solid carbon dioxide from chunks, at rate of 8 pounds per minute to minimize condensation of moisture into pulverized material; is simple to operate (requiring only that user drop chunks of dry ice into hopper); also reduces water ice to powder for calibrating thermometers and thermocouples. Pulverizer occupies 15 x 18 in. space on work table; weighs 80 lbs.; and is powered by a ¼-hp. motor.—*Franklin P. Miller & Son, Inc., 36 Meadow St., East Orange, N. J.*

For more information circle **259** on inquiry card.

Laboratory Bath

New "Magni-Whirl Jar Bath" features usability of working space and 100-percent visibility; obviates need for motors, stirrers or circulating systems; provides uniformity and agitation by means of gentle pulsation of "Magni-Whirl Perforated Agitator

Circle **63** on inquiry card. →
Instruments & Automation—Page 393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of wiring your plant without the protection of circuit breakers in the line!
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to operate pressured systems without the protection of
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Safety Heads

Just as an electrical circuit breaker protects your personnel, plant and equipment from electrical overloads, shorts and "burn-outs", so does the BS&B Safety Head protect them from the dangers of overpressure in pressured systems.

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The BS&B Safety Head is especially suited to use in oil and gas producing fields, pipe lines, refineries, chemical plants, power plants and the refrigeration industry. It may be used as either a primary or secondary relief device, and either upstream or downstream from a relief valve, as varying conditions may require.

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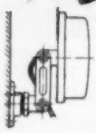
DIAL THERMOMETERS

in 3 types to suit any requirements

Full 4½" dial face. Stem can be placed at any angle and case can be rotated to any readable position.

1 **Rigid Stem Dial Thermometer** tapered bulb, interchangeable with standard industrial thermometer separable socket. (As illustrated above.)



2 **Wall Mounted Dial Thermometer** with flexible connecting armor. Case adjustable to easy reading position.

3 **Flush Mounted Dial Thermometer** for panel mounting with flexible connecting armor.

All three types have a full 4½" dial face.

for accuracy: Mercury actuated . . . Fully Compensated by Invar Compensaton. Guaranteed Accurate 1 scale division.

for angularity: Can be adjusted to most readable position at any angle desired.

for readability: Bold Black Numbers . . . 11" of scale Reading Dial face can always be placed in easiest readable position.

for interchangeability: Always specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.

Send for Bulletin 51-129 for details on the New Palmer Dial Thermometer.

PALMER
THERMOMETERS, INC.
Norwood Ave., Cincinnati 12, Ohio
Mfrs. of Industrial Laboratory Recording and Dial Thermometers

For more information circle **64** on inquiry card.

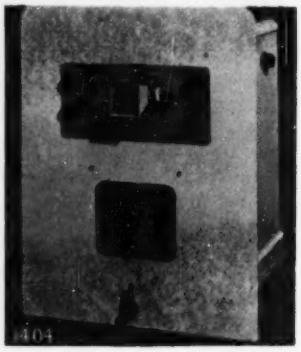
NEW INSTRUMENTS

Plate" produced by an electromagnet located in base support. "Automatic Dual Microtrol" permits automatic selection of any two most used temperatures within range of bath. (Other temperatures within range may be selected without disturbing these two settings.)—*Blue M Electric Co., 306-08 W. 69th St., Chicago 21, Ill.*

For more information circle **260** on inquiry card.

Micro Balance

New "Micro Gram-atic" 20-gram-capacity balance is said to represent "the first time that engineers have been able to design a single-pan constant-sensitivity micro balance." Chief characteristics are high accuracy (0.002 milligrams) and high speed (5-minute weighings cut to 35 seconds). Automatically-registering weights are not added but mechanically removed by dialing from front panel: no personal handling of weights and no calculating of final results.—*Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Penna.*



For more information circle **261** on inquiry card.

Grinding Mill

New ¼-hp. electric stone grinding mill is said to have exceptional efficiency in grinding tough, fibrous organic materials, certain plastics and molding compounds, is adjustable to nine degrees of fineness.—*Lee Engineering Co., 2023 W. Wisconsin Ave., Milwaukee 3, Wis.*

For more information circle **262** on inquiry card.

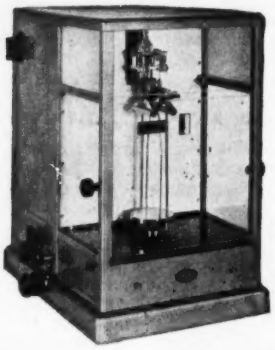
Hortvet Cryoscope

New model of Hortvet Cryoscope has been redesigned to make water-in-milk tests more conveniently. Stirring and ether vaporization have been mechanized. A collecting tube for ether fumes is furnished. Operation is simple. Dial is marked to read directly in terms of percent of water adulteration. Instrument is a complete "lab-in-the-hand," with all necessary accessories.—*Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.*

For more information circle **263** on inquiry card.

Analytical Balance

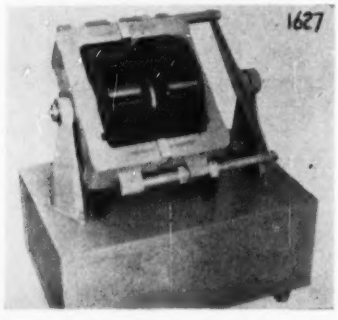
New "Emson Model S-M" single pan analytical balance (made in Western Germany) is said to minimize operator fatigue and give greatest speed, simplicity, reproducibility and dependability, by location of easily-manipulated weight-control knobs (at lower left side to permit operator to rest his elbows on table while selecting weights) and of reading scale (at eye level just above weighing pan). Operator sees substance being weighed at all times.—*E. Machlett & Son, 220 E. 23rd St., New York 10, N. Y.*



For more information circle **264** on inquiry card.

Laboratory Electromagnet

New "Model V-4007" multi-purpose 6-in. laboratory electromagnet offers wide range of field values and configurations; features changeable pole caps for uniform or high field work; adjustable gap providing a gap range from ¼ in. to 6 in.; dolly mount giv-



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If your particular testing problem involves flow rate measurement or some similar phase of hydraulics requiring special equipment, we invite you to submit your problem to us for research and study. A description of the process involved and all pertinent specifications should be included. If in the opinion of our hydraulics engineers the basic idea is practical, we will undertake design and development of the special equipment.

DESIGNING and building Cox Precision instruments has been the full time job of Commercial Research Laboratories, Inc. for over 40 years.

The experience and specialized "know-how" we have gained is evident in the great number of Cox instruments currently being used by the automotive and aircraft industries, and by the U.S. Airforce, Army, and Navy.

Today, as in the past, scientists and craftsmen here at Commercial Research Laboratories are hard at work developing new and improved Flow-Meters, Flow-Meter Calibrating Stands, Fuel Nozzle test stands, and other Cox precision testing devices to help you in meeting tomorrow's testing problems. At the same time, we stand ready to help in designing and building the accurate precision instruments your *immediate* testing problems require — whether for the research laboratory or the production line.

An example of modern CRL service is a flowmeter service department which we have just created. Using Cox Calibrating Stands, we are able to test any make or capacity flowmeter to determine to what *exact* percentage the instrument is accurate. In cases where design of the instrument will not allow re-calibration, correction curves can be supplied to guide users in future operation of the instrument.

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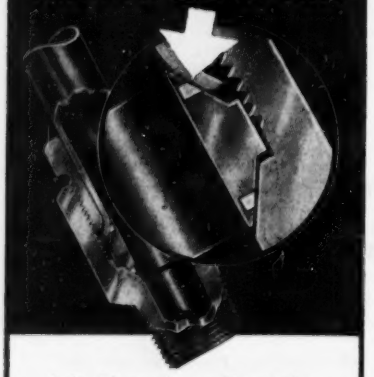
BALANCED ELECTRONIC EQUIPMENT FOR PRESSURE AND VIBRATIONS.

For more information circle **65** on inquiry card.

ONLY

Koncentrik

flared-tube fittings
(in Stainless or Monel)
give you the
PATENTED 2-WAY SEAL



1. Double-sealing, self-centering seat is Teflon-reinforced to give you DOUBLE protection against costly, dangerous leaks.

2. Heavy-duty, fatigue-proof . . . designed for high pressure use.

3. Easy to install.

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Our engineers will be glad to work closely with you in solving your special tube fitting problems.

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Literature covering Koncentrik fittings, and Powell valves with machined-in Koncentrik connections, now available. Write today.

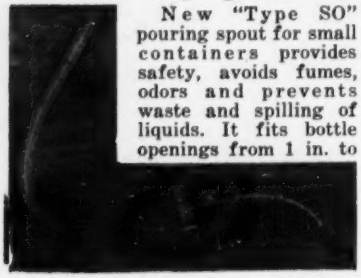
For more information circle **66** on inquiry card.

NEW INSTRUMENTS

ing complete mobility without loss of rigidity in operating positions; magnet yoke angle easily changed. ★Matching "Model V-2200" regulated magnet power supply has provisions for field modulating and nuclear-magnetic-resonance field controlling signals; offers maximum current regulation against line and load changes.—*Special Products Sales Dep't, Varian Associates, Palo Alto, Calif.*

For more information circle **265** on inquiry card.

Pouring Spout



New "Type SO" pouring spout for small containers provides safety, avoids fumes, odors and prevents waste and spilling of liquids. It fits bottle openings from 1 in. to 1-⅝ in.; has a flow capacity of slightly more than 1 gpm.—*General Scientific Equipment Co., 2700 W. Huntingdon St., Philadelphia 32, Pa.*

For more information circle **266** on inquiry card.

Hot Plate

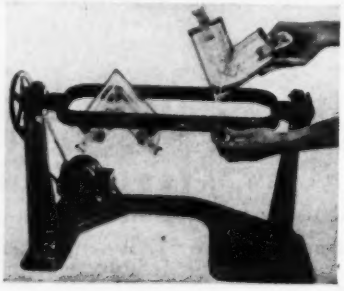
New "Temco Type 2600" heavy-duty lab and plant hot plate has 9-in. square smooth cast-iron top plate for

applications where aluminum is not suitable. Four-heat switch provides no-load surface temperatures of 400 F., 535 F., 710 F. and 930 F.—*Thermo Electric Mfg. Co., 496 Huff St., Dubuque, Iowa.*

For more information circle **267** on inquiry card.

Twin-shell Lab Blender

New yoke model is a small-scale laboratory twin-shell blender (smaller than current 4-quart size model): it accommodates two small blenders in a yoke which can be interchangeably mounted in standard 4- and 8-quart frame. Blender shells are made



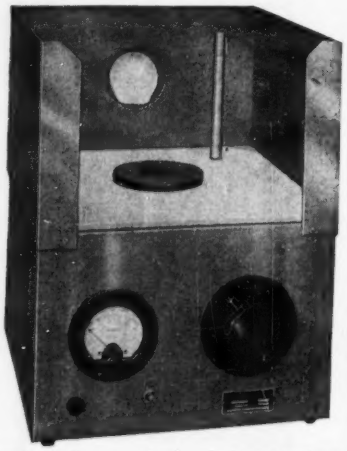
of Lucite in load capacities of 1, 2 and 4 pints with dust- and watertight quick-opening cover plates.—*The Patterson-Kelley Co., Inc., 638 Warren St., East Stroudsburg, Pa.*

For more information circle **268** on inquiry card.

FOR THE TESTING DEPARTMENT

Heat Source for Testers

New electric heat source provides controlled heat input for softening-point tests of bituminous materials



and makes control of temperature-rise rate easy and certain. (A.S.T.M. D36-26, D61-38, and E28-51, and Federal Spec. SS-R-406a tests). Once proper current setting has been established for container being used, all future tests can be run by setting current to proper value.—*American Instrument Co., Inc., Silver Spring, Md.*

For more information circle **269** on inquiry card.

Accelerometer Tester

New "Model D G-accelerator" is capable of testing accelerometers and other instruments under forces up to 850 *G*. Its speed range is infinitely variable from 20 to 1750 rpm.; radius of gyration variable from 5 to 12, in., giving *G*-range from 0.01 to 850. Mounting platform is a 24-in. diam. table with 108 tapped mounting holes; capacity 1000 *G*-pounds; as many as 6 identical objects can be tested simultaneously if arranged symmetrically. Test chamber can be sealed off for altitude tests and insulated for thermal tests. For determining table rotation speed precisely, tester has (1) a tachometer coupled directly to main drive shaft, (2) a strobe system which operates on line frequency; synchronous steps every 2-½ rpm. throughout total speed

THESE FLUIDS ARE DIFFICULT TO PUMP

ACETALDEHYDE	SODIUM CYANIDE	PROPIONIC ACID	SALT SOLUTIONS
ACETONE	SULFUR DIOXIDE	SULFURIC ACID	SODIUM SILICOFLUORIDE
FORMALDEHYDE	TRINITROCHLOROBENZENE	IODINE	HYDROGEN PEROXIDE
FREON	VINYLIDENE CHLORIDE	BENZOLCHLORIDE	HYDROCHLORIC ACID
MERCAPTANS	CHLOROSULFONIC ACID	BENZOLTRICHLORIDE	BROMINE TRIFLUORIDE
MERCURY	CHROMIC ACID	LIQUID BROMINE	CHLORINE
MOLTEN METALS	HYDROBROMIC ACID	CHLORACETIC ACID	CHLORINE TRIFLUORIDE
NAPHTHALENE (Molten)	NITRIC ACID	DILUTE ACIDS	FLUORINE GAS
NITRIC ACID	OLEUM	ALUMINUM SULFATE	HYDROFLUORIC ACID
PHOSPHORIC ACID	OXALIC ACID	DIATOMACEOUS EARTH SLURRY	HYDROGEN CYANIDE
		FERRIC SULFATE	HYDROGEN FLUORIDE
		SODIUM HYPOCHLORITE	FLUORINE
			SULFUR DICHLORIDE

THEY ARE HANDLED SUCCESSFULLY BY THE Lapp PULSAFEEDER

PISTON-DIAPHRAGM CONTROLLED-VOLUME CHEMICAL PUMP

Not competitive with any pump of more conventional design, the Lapp PULSAFEEDER is a highly specialized, precision, custom-built machine suited to a wide variety of special applications involving controlled-volume pumping of fluids.

Basic feature of Lapp PULSAFEEDER design is its combination of reciprocating piston action (to provide the accuracy of positive displacement) with an hydraulically balanced diaphragm which isolates material being pumped from working pump parts—and, of course, eliminates need for stuffing box or running seal.

Control of pumping rate is achieved at constant pumping speed; variable flow results from variation in piston stroke length—adjustable by hand-wheel, or, in Auto-Pneumatic models, by instrument air pressure responding to any instrument-measureable processing variable.

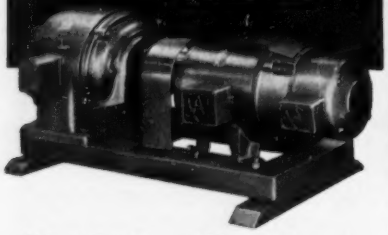
Justification for this specialized premium construction is evident in the many, and varied, applications in which Lapp PULSAFEEDER alone is able to perform satisfactorily. In fact, the economies of continuous processing, automatic proportioning, feeding and filling in many operations are possible only because of the unusual characteristics and peculiar advantages of Lapp PULSAFEEDER.

In general, use of the Lapp PULSAFEEDER is indicated for continuous (or intermittent) pumping, at accurately controlled volume, of fluids which cannot be satisfactorily exposed to conventional pistons, cylinders and stuffing box packing—because of the corrosive action of chemicals being handled and/or need for protection of product against contamination.

Lapp Bulletin 300 shows typical applications and flow charts. It describes and lists specifications of models over a wide range of capacities and special constructions. Also included is an Inquiry Data Sheet, from which we can make specific engineering recommendations for your processing requirement. For your copy write Lapp Insulator Co., Inc., Process Equipment Div., 124 Wilson St., Le Roy, N.Y.

For more information circle **67** on inquiry card.

Are your High-Cycle Alternator requirements *special?*



Where lowest possible maintenance, combined with excellent wave form characteristics are required, it's hard to match American Electric's Inductor-Type Alternators. But occasionally *special requirements arise* which may be better served by American Electric's Revolving Field Alternators.

Here Are Quick Facts:
AMERICAN ELECTRIC REVOLVING FIELD ALTERNATORS

CAPACITY RANGE—15 KVA to 40 KVA (in stock). Up to 75 KVA on special order.

FAST RECOVERY—Better than .2 seconds.

LOW VOLTAGE OVERSHOOT—Less than 10%.

TOTAL HARMONIC CONTENT—Under 5% on unbalanced 3-phase loads

These characteristics apply to general uses. Where applications are specific, even better characteristics can be developed.

EXCITER REGULATING SYSTEM

Employs American Electric's trouble-free, direct-connected, high-cycle Inductor Alternator—which has no commutator, slip rings, brushes, springs etc. Output is rectified and exciter-regulated by either electronic or magnetic amplifier means then returned to the rotating field of the main alternator.

Write for details and quotations outlining requirements.

Also Manufacturers of High Frequency Inductor Alternators, Miniature Electric Motors, A.C. Industrial Motors, Motor Driven Blowers and Fans.

AMERICAN ELECTRIC MOTORS — 1601 Telegraph Road, Los Angeles 22, California

FIELD ENGINEERING REPRESENTATIVES:
TRAVCO ENGINEERING COMPANY—Silver Spring (Md.) • Boston • Buffalo • New York City • Chicago • Dallas • Kansas City • Wright Field • Minneapolis • Seattle • Montreal • Toronto •
JOE DAVIDSON & ASSOCIATES, Los Angeles.

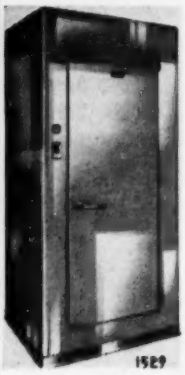
For more information circle **68** on inquiry card.

NEW INSTRUMENTS

range. These two systems indicate speeds within 0.1 percent accuracy, or to accuracy of available line-frequency.—*Genisco, Inc.*, 2233 *Federal Ave., Los Angeles* 64, *Calif.*

For more information circle **270** on inquiry card.

Constant-temperature Rooms



New "Labrooms" are 4 ft. wide x 7 ft. high inside; 4 depths from 2-ft.-deep reach-in type to 8-ft.-deep walk-in types. Temperature 40 F. to 140 F. Features include aluminum shelves, circulating blowers, dual adjustable thermostats, thermo-pane window, fluorescent lights, safety locks, aluminum walls and heavy insulation. Small size shipped assembled; larger sizes knocked down, will go through standard doorway. All prewired.—*Labline, Inc.*, 217 *N. Desplaines St., Chicago* 6, *Ill.*

For more information circle **271** on inquiry card.

Weather-resistance Tester

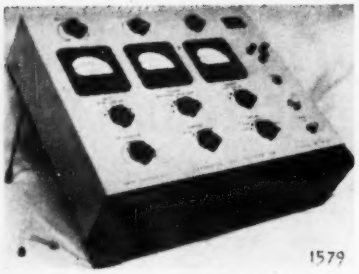
New "Model DMC Weather-Ometer" has accuracy in test results increased by a positive control of specimen temperatures. Automatic control

of humidities up to dew point is available as optional equipment. All automatic controls, including complete voltage controls, are located on eye-high panel. Both horizontal and vertical testing available: cup containers for bitumens and other semi-liquid materials and vertical panels for solid materials.—*Atlas Electric Devices Co.*, 361 *W. Superior St., Chicago* 10, *Ill.*

For more information circle **272** on inquiry card.

Transistor Tester

New "Type 210 Transistor Test Set," for use in circuit laboratory, inspection department, and on production line, measures equivalent circuit parameters of both junction and point-contact units over a wide range of d-c. conditions. No accessory equipment is necessary, and operation is simple and straightforward. Internal generator



operates at 1.5 kc. and a-c. voltmeter has a sensitivity of 1 mv. full-scale.—*Owen Laboratories*, 412 *Woodward Blvd., Pasadena* 10, *Calif.*

For more information circle **273** on inquiry card.

Cathode-ray Checker

New "Model 630 C-R Tube Checker," available in kit and wired form, tests all sizes of TV picture and os-

cilloscope type c-r. tubes in the set itself or in the carton.—*Electronic Instrument Co., Inc.*, 84 *Withers St., Brooklyn* 11, *N.Y.*

For more information circle **274** on inquiry card.

HERCULES
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STEEL TYPE HOLDERS

for interchangeable numbering in a straight line. Make serial or random numbering easy.

To use — just press thumb-clip, insert "Heavy-Duty" Shoulder-Style Steel Type, hold over position and hit with a hammer.

Furnished with round shank for press use also. Other models available for marking convexed or concaved surfaces—***with standard type.***

Write for latest literature and price lists.

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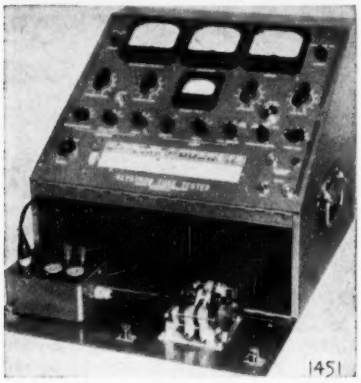
3-11 MORRELL ST.
ELIZABETH 4, NEW JERSEY
"The Original Marking Specialists"

For more information circle **69** on inquiry card.

Klystron Tube Tester

New Klystron Tube Tester, first commercial instrument of its type, tests performance quality of all com-



mercially available klystron-type tubes for internal and external cavity construction; has precautionary means for safe testing, tube data charts for rapidly determining control settings, provisions for external modulation.—*Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn 11, N. Y.*

For more information circle **275** on inquiry card.

ELECTRICAL INSTRUMENTS

VTVM

New "Model 1520" vacuum-tube voltmeter covers total voltage range from 500 microvolts to 500 volts (rms) in six ranges, over a frequency range from 15 cps. to 250 kc.; is calibrated both in ac. voltage and decibels; voltage range of scale is from 0.5 to 5.0 volts; decibel range is from −5 to +17 db based on zero db equalling one milliwatt in 600 ohms. Input impedance 2 megohms with 15 mmf shunt capacity; accuracy 2 percent from 15 cps. to 250 kc.; stability 1 percent with line voltage variation from 105 to 125 volts. Amplifier available for external use by rotation of ac. output control; voltage gain 1600 (63db).—*Communication Measurements Laboratory, Inc., 350 Leland Ave., Plainfield, N. J.*

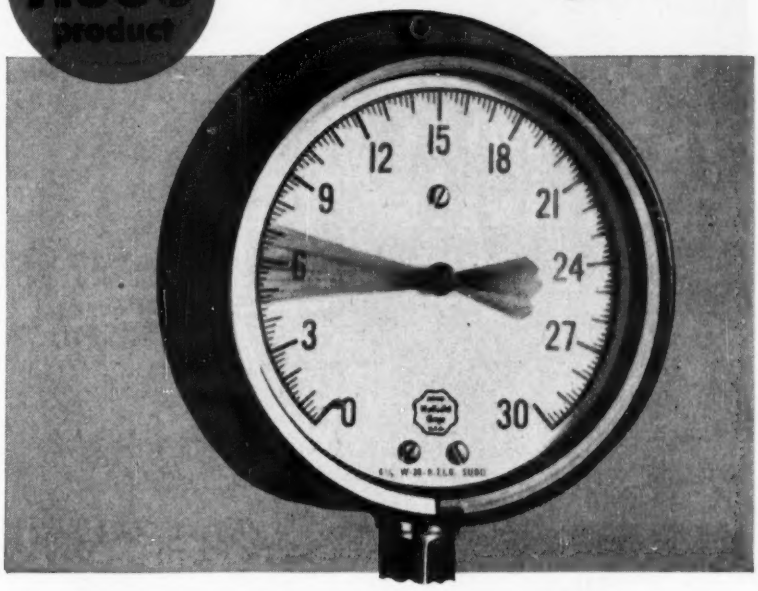
For more information circle **276** on inquiry card.

Microwave Calorimeter

New "Model SME Microwave Calorimeter and Dummy Load," for measurement and absorption of microwave power of any magnitude between 500 and 90,000 Mc., is said to "outperform previously known calorimeters in accuracy and power/fre-

an ACCO product

Helicoid Gages



Flutter Won't Hurt Them!

HELICOID Gages are designed to withstand many millions of pressure pulsations. Flutter and rapid surges have no effect on their accurate performance in long-life service. Tests show 75,000,000 cycles at 1200 pulsations per minute without wear.

1. There are no gears to wear out

Only HELICOID Gages offer this long-lasting gage movement. There are no gears, no teeth to wear out. Cam wiping action keeps contact points clean and smooth.

2. Bourdon tubes won't stretch, leak or crack

Bourdon tubes in HELICOID Gages give maximum torque and minimum stress to promote greatest possible endurance life. Will withstand millions of pressure pulsations without stretching, leaking or cracking.

HELICOID Gages for Pressure, Vacuum or Compound Service

There are HELICOID Gages for all pressure ranges —with white, black or radiant faces—wall, stem, flush and panel mountings for flangeless cases. See your distributor today or write for **Catalog G-2.**

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For more information circle **70** on inquiry card.

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- Stabilization
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- Hardening
- Super-Hardening
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Tenney Sub-Arctic Industrial Cabinets are adaptable to all these important applications—wherever low temperature refrigeration with constant control, rapid pull-down, reliability of operation, and minimum maintenance are essential to operations. There are 28 models available in standard and special units in 1, 4, 6, 9, and 12-cu. ft. capacities, either air- or water-cooled. And for low temperature points, there is a range of six ratings: −40, −80, −100, −120, −150, and −170° F.

For features, specifications, and optional equipment, write for Sub-Arctic Bulletin.

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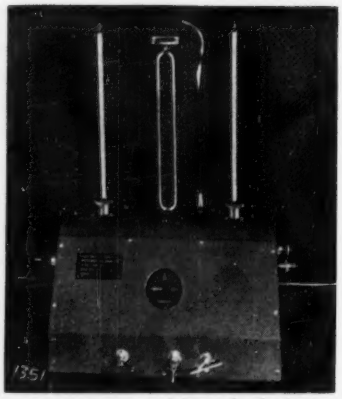
Engineers and Manufacturers of Automatic Environmental Test Equipment

For more information circle **71** on inquiry card.

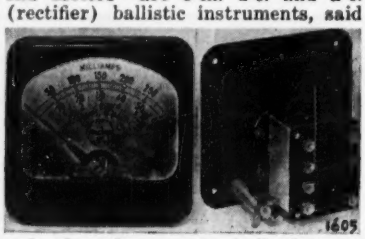


quency coverage with a single instrument." New design is said to permit a selling price "approximately 25 percent of usual past costs for such devices." Its power range is from fractional-watt to over 50,000 watts average power. With slight modifications, it is adaptable for calorimetry of any liquid or gas.—*Sightmaster of California Co., Gillespie Airport, Santee, Calif.*

For more information circle **277** on inquiry card.

Ballistic Instruments

New "Milliampere-Milliampere Second Meters" are 5-in. d-c. and a-c. (rectifier) ballistic instruments, said



to be the only ones now built that use large movements required to achieve requisite sluggish action; can be furnished in any types and ranges (except highly sensitive); are suitable for production-line testing. For example, maker states that most sensitive practical range is 0-200 microamperes, with resistance of 2500 ohms owing to long length of wire per ampere-turn. Dials are hand-drawn for each order. Illustrated instrument is illuminated by means of two Lucite rods which carry light from incandescent bulbs replaceable from rear of panel.—*The Hickok Electrical Instrument Co., 10519 Dupont Ave., Cleveland 8, Ohio.*

For more information circle **278** on inquiry card.

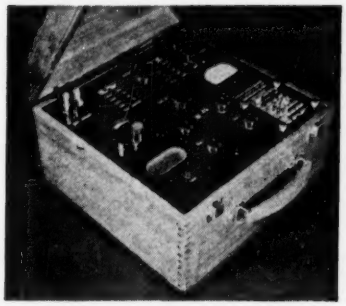
Frequency Meters

Three new precision frequency meters, accurate to 0.001 percent, are for use by organizations concerned with installation and maintenance of communication systems. "Model LA-5" provides frequency measurements at 10 to 100 Mc.; "Model LA-6" 100 to 500 Mc.; "Model LA-61" 500 to 2000 Mc. All are 2 cu. ft. in volume, and said to be simple to operate under field and laboratory conditions.—*Lavoie Laboratories, Inc., Morganville, N. J.*

For more information circle **279** on inquiry card.

Transfer-type Volt-ammeter

New "Transfer Volt-Ammeter" for measurement of current and voltage to accuracy of 0.05 percent over en-

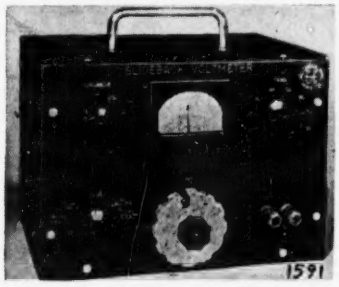


tire a-f. range is a multi-range standard originally developed by F. L. Hermach of the NBS. It utilizes transfer technique, is used with an external d-c. potentiometer and thereby extends range of precision potentiometry to voltage and current measurements from 20 to 20,000 cps. Thermal converter is transferred to an internal d-c. circuit for each measurement so that accuracy does not depend on thermocouple but on stable resistors and on potentiometer. Ranges: 100 ma. to 5 amps. and 15 to 300 volts. External shunts and multipliers are available to extend ranges. NBS Certificate (at extra cost).—*Charles Engelhard, Inc.* 850 *Passaic Ave., East Newark, N. J.*

For more information circle **280** on inquiry card.

Slideback Voltmeter

New Slideback Voltmeter is designed for precision measurement of voltages on absolute or relative basis. For ratios of 300 volts, dials are di-



rect-reading to six places. For absolute readings a standard cell is encased with each unit to permit adjustments of voltages to an absolute value. For relative readings, instrument may be connected to a prime source and used to adjust other voltages to a ratio of prime source or to determine ratio between two voltages. Indicator permits sensitivity of 0.2 microampere.—*Cal-Tronics Corp.,* 11307 *Hindry Ave., Los Angeles* 45, *Calif.*

For more information circle **281** on inquiry card.

Telegraph Distortion Analyzer

New "Model TDA-1 Telegraph Distortion Analyzer" measures bias and distortion of teletype signals, circuits and equipment. Percent distortion is read directly on calibrated scale in front of cathode-ray tube. Distortion-

Circle **72** on inquiry card. ⟶

PANALARM "50" ANNUNCIATOR SYSTEMS

NEW functional flexibility with NEW "instrument-type" construction

PANALARM "50" PLUG-IN UNIT . . . hermetically sealed and most versatile ever developed . . . simply plugs into chassis to expand system . . . no wiring . . . no other connections. Corrosion-proof and suitable for Class I, Div. 2 locations.

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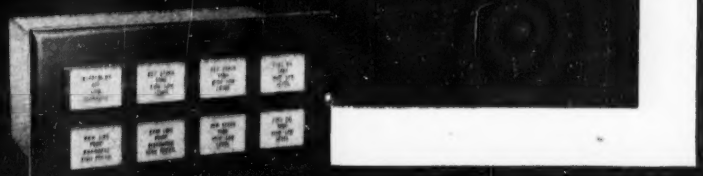
CABINET is substantial gauge steel with sturdy chassis and sub-door arrangement. It is pre-wired ready for installation, yet completely flexible without re-wiring.



PANALARM ANNUNCIATOR SYSTEMS are self-contained with either illuminated name-plates or bullseye visual signals. Both the audible signal and acknowledgment button are common to the entire system.

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An adjustable . . .
Sub-miniature potentiometer
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BOURNS TRIMPOT is a wire-wound potentiometer designed for miniaturized equipment. Adjustments of the 25 turn slotted shaft are made with a screw driver.

Accurate electrical settings in increments of ¼ to ½% are easily controlled and are securely retained without the use of lock-nuts.

Vibration of 15G at 10-2000 cps or a sustained acceleration of 100G does not interfere with the dependable performance of the TRIMPOT.

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6135 Magnolia Ave., Riverside, California
Technical Bulletin on request, Dept. 22

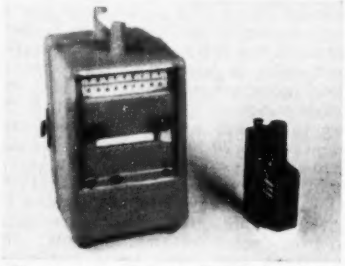
For more information circle **73** on inquiry card.

components making up total distortion are clearly indicated. No test signals are required. Measurements are made on regular teleprinter traffic. Instrument weighs 15 lbs., can be carried and plugged into working circuits at various repeater or terminal points, requires neither skill nor technical knowledge to operate.—*Stelma, Inc., 389 Ludlow St., Stamford, Conn.*

For more information circle **282** on inquiry card.

Ruggedized Galvanometer

New "Model 60A" ruggedized galvanometer and "Model 61A Display Box" are for field and laboratory use. Galvanometer suspension is to-

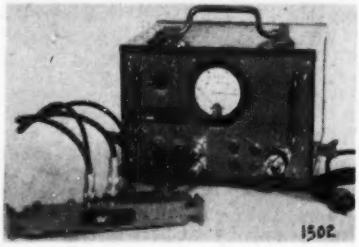


tally immersed in a liquid having a specific gravity equal to mean density of suspension: resultant assembly is consequently impervious to linear acceleration and shock during operation. Sensitivity as great as 10^{-8} amp. for 1 mm. deflection at one meter is available. Box provides a calibrated, illuminated spot display. Maximum full-scale sensitivity is 0.2 microamp.—*Electro-Mechanical Research, Inc., P. O. Box 307, Ridgefield, Conn.*

For more information circle **283** on inquiry card.

VSWR Instrumentation

New "Model 620" is a compact commercial version of maker's "AN/UPM-12 Automatic VSWR Instrumentation System" whose reliability,

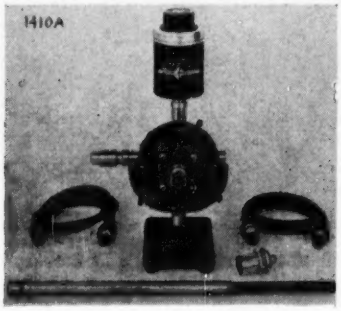


ruggedness and accuracy are said to have been "proven through rigorous military evaluation and use." Design is said to provide for continuous unequivocal measurements even in hands of untrained personnel. Manufactured presently for X-band; r-f. components for automatic VSWR measurements on S through Ku band will soon be available. ★ "Model 621," companion instrument for laboratory bench use, is available for analysis of microwave systems at carrier power levels supplied by signal generators.—*Cubic Corporation, 2841 Canon St., San Diego 6, Calif.*

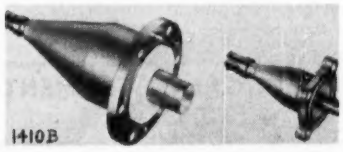
For more information circle **284** on inquiry card.

Admittance Meter, Adapters

New "Type 1602-B" is improved version of maker's UHF Admittance Meter: effect of junction inductance has been eliminated; accuracy has



been improved by several additional calibrated points on multiplying-factor scale; at low frequencies a small shielded variable air capacitor replaces long adjustable stub previously used as a susceptance standard.

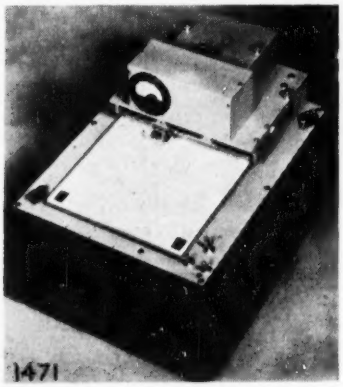


Among new accessories are "Type 874-QU3 and 874-QV2A Adaptors" (Fig. B) which permit connecting to rigid coaxial lines in UHF and VHF antenna systems; others available to connect to UG-type connectors.—*General Radio Co., Cambridge* 39, *Mass.*

For more information circle **285** on inquiry card.

Polar Recorder

New "Model PR," for recording of antenna patterns and patterns of other directional devices, has chart table driven by a Selsyn motor through

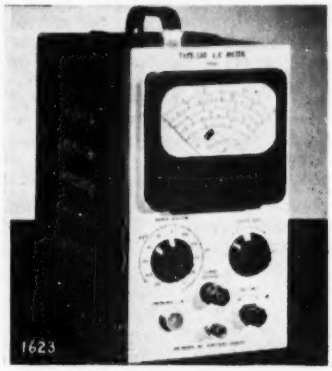


gear reduction (36:1 or 100:1 standard, other ratios special). Polar chart diam. is 8-¼ in.; recording width of 4-⅛ in. can be covered from 0-20 db up to 0-80 db. Interchangeable linear, square root, and squaring scales are available. Frequency response is from 20 to 200 kc. and over. Electronic circuit can be supplied for a.c. or for a.c.-d.c. signal recording.—*Sound Apparatus Co., Stirling, N. J.*

For more information circle **286** on inquiry card.

Inductance and Capacitance Measuring Instrument

New "Type 130 L,C Meter" is a direct-reading instrument for small values of inductance and capacitance

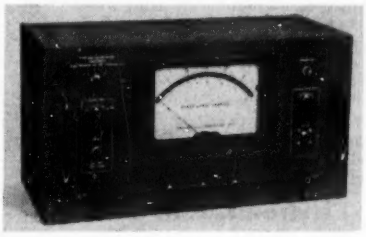


in components and circuits. Five ranges: 0/3/10/30/100/300 microhenries or micromicrofarads, accurate within 5 percent of full scale. Coarse and fine zero-adjust controls. Designed for the development engineer, but also convenient for component testing, sorting, and color code checking on a production basis.—*Tektronix, Inc., P.O. Box* 831, *Portland* 7, *Oregon.*

For more information circle **287** on inquiry card.

Phase Meter

New "Type 405 Phase Meter" presents phase angle directly in degrees and permits plotting phase-frequency



curves on a c-r. 'scope or mechanical recorder; is suitable for production work because it is simple to operate; no amplitude or zero adjustment and independent of variation in signal frequency. In addition, high sensitivity (0.1 v.) and extreme bandwidth (8 cps. to 100 kc.) make it suitable for development and research laboratories.—*Advance Electronics Co., Inc.,* 451 *Highland Ave., Passaic, N. J.*

For more information circle **288** on inquiry card.

Panel-mounting VTVM

New "Type A Vacuum Tube Voltmeter" is a miniaturized panel-mounting version of familiar lab instrument requiring same panel area as a standard 3½-in. indicating instrument and having a depth of 4¼ in. Designed for incorporation in production test equipment and in light-weight airborne or portable equipment, it is available with full-scale sensitivities from 10 mv. rms. to 300 volts rms.; input impedance 1 megohm; accuracy 3 percent; frequency range 20 to 50,000 cps. Standard model does not include

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CUSTOM-DESIGNED

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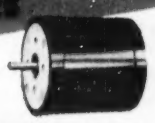
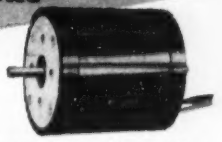


Custom-designed to start and synchronize high inertia loads quietly and smoothly . . . remaining independent of line and load fluctuations . . . and operate at various synchronous speeds by switching.

GIANNINI
SALIENT POLE MOTORS



Custom-designed to synchronize in particular shaft angular positions at minimum noise level. Especially well suited for framing, registering or similar applications.

May we cooperate in the design and development of your projects involving synchronous motors and other rotary electro-magnetic devices?

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For more information circle **74** on inquiry card.

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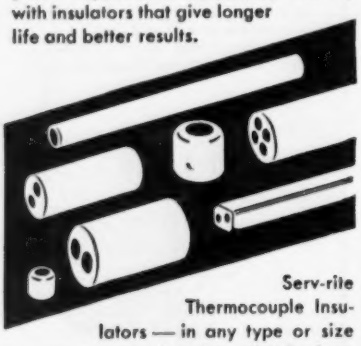
THERMOCOUPLE INSULATORS

This Gordon Thermocouple Insulator, heated red hot and plunged into cold water, came out just as good as new

Available only through GORDON, Serv-rite Thermocouple Insulators are made to stand the gaff of excessive thermal shock far above normal requirements.

For sturdy and reliable thermocouple insulator performance to meet peak production needs—specify Serv-rite . . . a development backed by Gordon's many years' experience in supplying industry with insulators that give longer life and better results.



Serv-rite Thermocouple Insulators — in any type or size — can be supplied immediately from Gordon's large stocks in the Chicago and Cleveland plants. Remember — you can always distinguish Serv-rite Insulators by their tan color.

Fish Spine Beads
Asbestos Tubing
Double Hole Round
Asbestos String
Single Hole
Double Hole Oval

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For more information circle **75** on inquiry card.

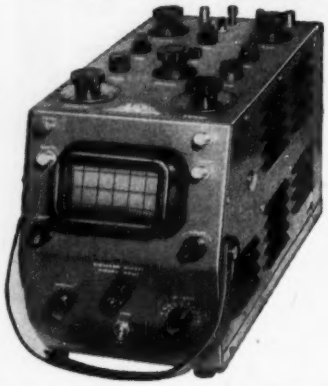
NEW INSTRUMENTS

a power supply, utilizes available filament and plate voltages; other models include power supply for applications that require a self-contained unit; can be provided with multiple scales or higher input impedances; for military applications a ruggedized version utilizes latest MIL-M-10304 indicator and hermetically-sealed components.—*Trio Labs., P. O. Box 143, Wantagh, N. Y.*

For more information circle **289** on inquiry card.

Pulse-study CRO

New model of "Pulsescope," in "Pocketscope" size, features instantaneous direct-reading d-c. calibration of either positive or negative going



signals; vertical amplifier sensitivity of 0.2 v.rms/in.; response from d.c. to 5 Mc. within 3 db or pulse rise of 0.3 usec. and internal intensity modulated markers of 1, 10, 100 or 1,000 usec. Repetitive or trigger sweep is variable from 5 cps. to 500 kc. with 5X sweep expansion. Sweep, marker and d-c. calibrating voltage available externally. Operates from 50 to 400 cycles at 115 v.ac.—*Waterman Products Co., Philadelphia 25, Pa.*

For more information circle **290** on inquiry card.

Electronic Null Detector

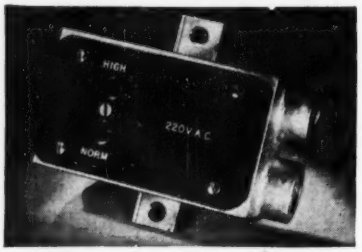
New "Model 200A Null Detector" is a wide-band (10 cps. to 5 Mc. useful) quasi-logarithmic voltmeter usable in lab or plant as a balance indi-

cator for a-c. measuring bridges and as a signal tracing voltmeter of large dynamic range. On-scale range of 120 db (1,000,000-to-1) and log relation prevent overload by large unbalance. Approach to null is never obscured. Sensitivity automatically increases with approach to balance. "Model 200A" is said to replace more-expensive less-adaptable voltmeters and oscilloscopes.—*Deltron Inc., P.O. Box 192, Glenside, Penna.*

For more information circle **291** on inquiry card.

Voltage Indicators

New "Model 960" and "Model 961" high-low voltage indicators have two glow-lamp pilot lights marked HIGH



and NORM, and two test jack receptors; are for use with equipment whose efficiency depends upon a certain voltage range. "Model 961" indicates a low of 95 to 105 volts and a high of 130 to 140 volts a.c. or d.c.; "Model 960" 190-210 and 235-255. Other voltage ranges on special order. Test jack receptors are for checking with a voltmeter at any time.—*Industrial Devices, Inc., Edgewater, N. J.*

For more information circle **292** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

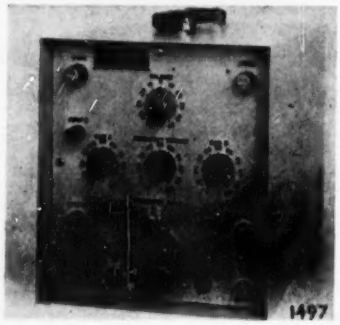
Oscillograph Galvanometer

New "Type 40-100" supersensitive galvanometer, designed for use with relatively high impedance pickups, is interchangeable with all other types of maker's galvanometers. Frequency 40 cps., sensitivity 2.8 microamperes per inch (12-in. optical arm), external damping resistance 1000 ohms, and coil resistance 109 ohms. Other features include solid dustproof case, rotational limit stop, improved connector terminal, rapid horizontal and vertical adjustment.—*Heiland Research Corp., 130 E. Fifth Ave., Denver 9, Colo.*

For more information circle **293** on inquiry card.

Electronic Switch for Two Displays on One 'Scope

New electronic switch makes possible simultaneous observation of two patterns on one CRO screen. Relative



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Thermopiles

For many years the thermopile has been the accepted instrument for measuring Radiant Heat from Radiant Heaters at the American Gas Association Testing Laboratory in Cleveland, Ohio. Since 1930, when Vandaveer first described his work in this field,* an Eppley thermopile has been used for this purpose in hundreds of tests and the results have been consistent and accurate to within 1 per cent.

This is but one of many applications in the field of radiant energy measurements for which Eppley Thermopiles are ideally suited. They may be obtained with windows of different materials, and various types of black are available for receiver coatings.

All Eppley Thermopiles are supplied with a certificate of calibration, this calibration being made against a Standard Lamp from the National Bureau of Standards.

If you have a problem involving the measurement of radiant energy we invite you to write us, describing your problem in as much detail as possible. We will be glad to make recommendations and there will be no obligation.

*Vandaveer, *Industrial & Engineering Chemistry*, Vol. 22, page 596, June 1930.

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For more information circle **76** on inquiry card.

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- ◆ Model 250-C1 Impedance Bridge $340
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For discrete point plotting or continuous-trace recordings on standard graph paper, Librascope produces a two coordinate portable recording instrument called the X-Y Plotter and Recorder. This unit is noteworthy for rapidity and accuracy of performance and is applicable to a great variety of data reduction operations.

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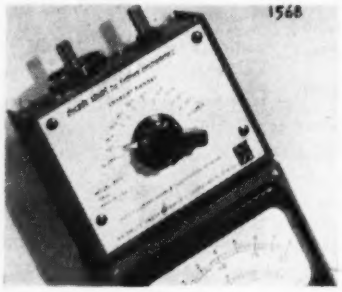
postions of patterns may be varied so that they are either superimposed or separated, permitting direct comparison of amplitudes, waveforms, frequencies and phase relationships. A square-wave voltage of variable frequency and amplitude is available at output terminals for use as a test signal. Unit incorporates direct-coupled amplifiers which are alternately operative and inoperative at a rate determined by selected switching frequency; is therefore effective for chopping a d-c. signal, making it suitable for transmission through scope amplifiers.—*Chatham Electronics Corp., Livingston, N. J.*

For more information circle **294** on inquiry card.

Electrometer Shunt

New "Model 2008 Decade Shunt," for measuring currents as low as 5 x 10^{-14} amp., plugs onto maker's

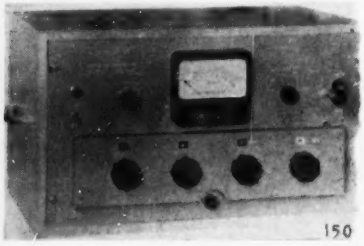


electrometer, converting it to a direct-reading micromicroammeter. Using both 2- and 8-volt ranges of "Model 200A Electrometer" results in 20 overlapping current ranges. Absolute accuracy is within 6 percent of all lower-scale readings, and within 3 percent of full-scale readings. Time constant is within 2 seconds on all ranges, except 10^{-12} ranges where it is about 10 seconds.—*Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio.*

For more information circle **295** on inquiry card.

Signal Generator

New "Decalator 100-1" provides decade selection of 9000 predetermined crystal-controlled frequencies,



in 100-cps. steps over range from 100 kc. to 1 Mc. Frequency selection is by a series of window-type dials. Two banks of crystals control output: short-term stability of 5 cps. and over-all accuracy within 0.025 percent. Output voltage is 3 volts maximum, into 600 ohms, with a total harmonic content of less than 3 percent at any frequency.—*Decade Instrument Co., Box 153, Caldwell, N. J.*

For more information circle **296** on inquiry card.

Random Noise Generator

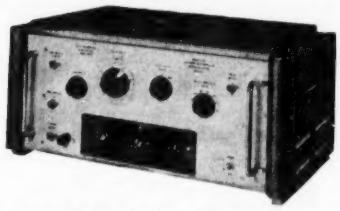
New "Type 811-A Random Noise Generator" provides entirely random noise with good normal (Gaussian) amplitude distribution; is useful for

tests in design and production of sound apparatus, for calibrating acoustical instruments, for making acoustic or psycho-acoustic measurements, etc. Three noise ranges: In a-f. and r-f. ranges, noise is "white" (uniform frequency spectrum having equal power in equal bands); in ASA range, noise meets ASA standard Z24.3-1944. —*Hermon Hosmer Scott*, 385 *Putnam Ave., Cambridge* 39, *Mass.*

For more information circle **297** on inquiry card.

Pulse Generator

New "Model OPS 100," said to set "a new standard in the speed and convenience of testing pulse circuitry,"

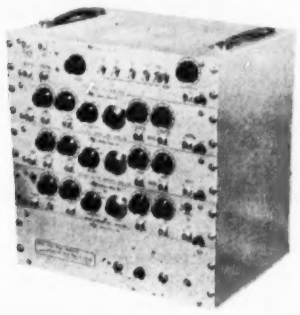


permits pulses to be viewed and measured at any position on CRO time base trace; produces a positive pulse output of up to 70 volts continuously variable in width from 1 to 250 usec., with freedom from ringing, droop or overshoot. Pulse shape is independent of frequency, load conditions, output voltage or output attenuator settings.—*Dep't IM, Marconi Instruments, Ltd.*, 23/25 *Beaver St., New York* 4, *N. Y.*

For more information circle **298** on inquiry card.

Pulse Generator

New "Model 2120A" pulse generator, constructed on block-unitized principle, generates a positive or negative main pulse whose width, amplitude, and delay from trigger are continuously variable; uses no gas tubes in pulse-forming circuits; provides repetition rates to 100,000 cps., along



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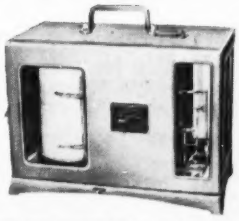

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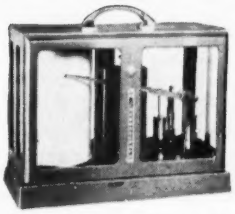

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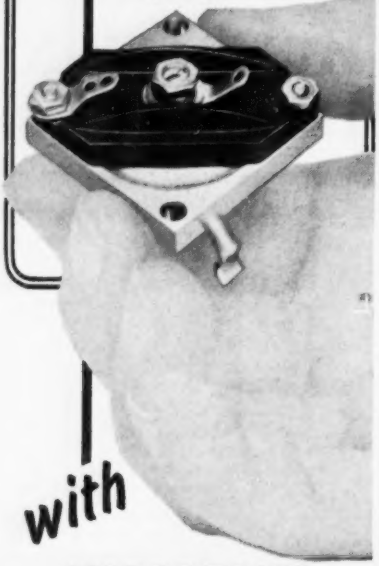

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For more information circle **80** on inquiry card.

NEW INSTRUMENTS

with single-pulse and gated operation. Risetime of main pulse is 0.02 usec. on all ranges; fall time is 0.03 usec.—*Electro-Pulse, Inc.*, 11811 *Major St., Culver City, Calif.*

For more information circle **299** on inquiry card.

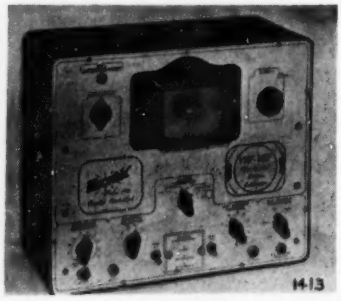
UHF Grid-dip Oscillator

New "Model 200," said to be the only grid-dip oscillator in 400 to 900 Mc. range, combines power supply and oscillator. Features: single range, no plug-in coils, no internal resonances. Uses: As grid-dip meter to determine resonant frequency of tank circuits, traps, etc.; as absorption wavemeter to detect spurious signals; as oscillating or absorption marker for use with sweep-frequency oscillator, etc.—*New London Instrument Co., New London, Conn.*

For more information circle **300** on inquiry card.

UHF-VHF Marker Generator

New "Model 690" covers span from 4.25 to over 225 Mc. on fundamentals with a 0.25-volt RF output; provides

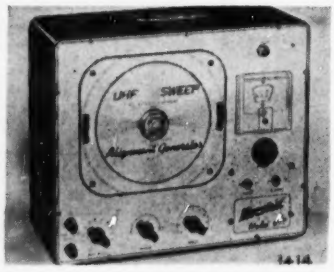


dual markers with any TV sweep generator; has exceptional (0.05-percent) accuracy of marker setting made possible by projecting magnified scale on a ground glass, so that 45 inches of dial can be self-calibrated to accuracy of unit's crystal calibrator.—*The Hickok Electrical Instrument Co.*, 10528 *Dupont Ave., Cleveland* 8, *Ohio.*

For more information circle **301** on inquiry card.

Sweep Alignment Generator

New "Model 697," said to be an entirely new instrument for UHF alignment, features an all-electronic sweep; fundamental output on channels 14



to 83 with 0.5-v. r.f. output; continuous tuning; blanking of oscillator to give reference baseline; piston type attenuator with better than 100 db attenuation.—*The Hickok Electrical Instrument Co.*, 10519 *Dupont Ave., Cleveland* 8, *Ohio.*

For more information circle **302** on inquiry card.

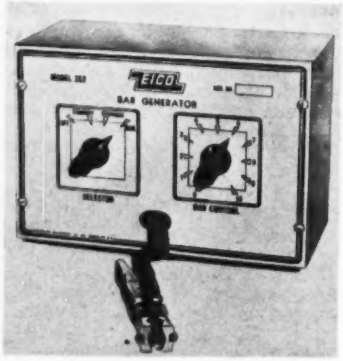
UHF Sweep Generator

New "Model 130" UHF TV sweep generator operates from 450 to 900 Mc., with single range tuning. Features: one-tube r-f. circuit, 1-volt output into 75 ohms, 0-30 Mc. sweep width, signal blanked on return sweep, no beating, balun available for 300-ohm balanced load.—*New London Instrument Co., New London, Conn.*

For more information circle **303** on inquiry card.

Bar Generator

New "Model 352" bar generator, available in kit or factory-wired form, provides series of vertical or horizontal bars on TV screen when connected



to TV antenna terminals. Operates on TV channels 3, 4, or 5.—*Electronic Instrument Co.*, 84 *Withers St., Brooklyn, N. Y.*

For more information circle **304** on inquiry card.

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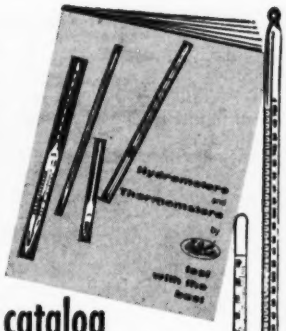

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For more information circle **82** on inquiry card.

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For more information circle **83** on inquiry card.

HF Generator

New "AM-1 Interpolator," when supplied with a standard 100-kc. signal, and when used with auxiliary

measuring equipment in range of 1 to 2 Mc., provides a system of measurement or generation of frequency in range of 20 to 1,000 Mc. with an accuracy of better than 1 part in 10^7 depending on accuracy of 100-kc. crystal source.—*Gertsch Products, Inc.*, 11846-48 *Mississippi Ave., Los Angeles* 25, *Calif.*

For more information circle **305** on inquiry card.

UHF Transformer-balun

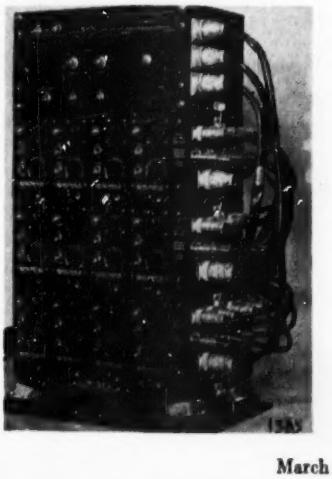
New "U-1, U-2 Transformer-Balun Combination" is an impedance-matching device for transforming output impedance of an unbalanced source of voltage, such as a signal generator, noise generator or sweeper, to a balanced 300-ohm output. Covering 400-900 Mc. portion of spectrum, units are designed to facilitate measurements in UHF-TV band. Overall SWR of combination from 400-900 Mc. is less than 1.2.—*Linear Equipment Labs., Brightwater Place, Massapequa, L. I., N. Y.*

For more information circle **306** on inquiry card.

AMPLIFIERS

Multi-channel Amplifier System for Oscillography

New "D" version of maker's unitized multi-channel amplifier system offers extended carrier-amplifier range and increased data capacity. Both linear-integrating and carrier amplifier units may be used in any combination up to 12 to permit simultaneous use of self-generating and externally-excited pickups. Phenom-



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For more information circle **84** on inquiry card.

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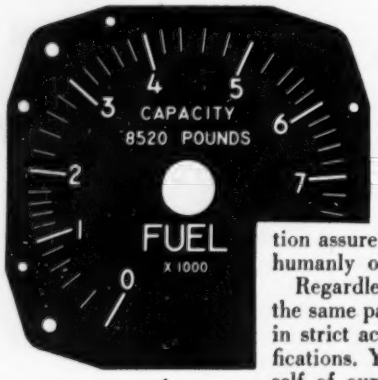

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U·S RADIUM

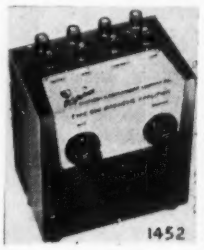
For more information circle **85** on inquiry card.

ena in 0-5000 cps. range may be amplified and system output coupled to any oscillograph equipped with galvanometers of matched characteristics.—*Consolidated Engineering Corp., Pasadena* 15, *Calif.*

For more information circle **307** on inquiry card.

Magnetic Amplifier

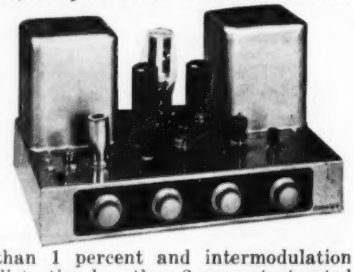
New "Type 806" operates on 115 v.ac.; can amplify output of a thermocouple, phototube, strain gage, etc. (as low as 0.2 microwatt) sufficiently to operate a relay or a deflection-type instrument. It will provide an output of 50 milliwatts of reversible polarity to a 50-ohm load. Power gain of approx. 300,000 can be obtained. Two feedback windings are provided and can be connected externally.—*Polytechnic Research & Dev't Co., Inc., 55 Johnson St., Brooklyn, N. Y.*



For more information circle **308** on inquiry card.

Hi-fi Amplifier

New "Golden Knight" 24-watt amplifier has frequency response at 24-watt output of ± 0.75 db from 20 to 40,000 cps. Harmonic distortion is less than 1 percent and intermodulation distortion less than 2 percent at rated output. Four inputs: one for a high-impedance microphone; two for radio tuner, crystal cartridge, TV, or tape recorder; one for magnetic cartridges; separate bass and treble tone controls. —*Allied Radio Corp.,* 100 *N. Western Ave., Chicago* 80, *Ill.*



For more information circle **309** on inquiry card.

Equalizer-preamplifier

New "121-A Dynaural Equalizer-Preamplifier" is a self-powered remote-control unit for broadcast or home sound systems, featuring continuously-variable record equalization. Bass turnover equalization is continuously variable, turnover frequency from 250 to 800 cps. and extent of maximum bass boost from 12 to 22 db. Rolloff equalization is separately and continuously adjustable from 0 to −22 db at 10 kc. Built-in "Dynaural Noise Suppressor" dynamically suppresses turntable rumble and record scratch without audible loss of musical frequencies.—*Hermon Hosmer Scott, Inc.,* 385 *Putnam Ave., Cambridge* 39, *Mass.*

For more information circle **310** on inquiry card.

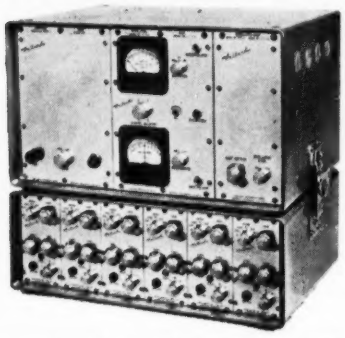
Miniature Amplifier

New "Type 5117 Miniature Plug-in Audio Amplifier," for radio and TV broadcast, recording studio and sound system use, is a two-stage push-pull fixed-gain unit, conservatively rated at 8 watts; is said to be "undoubtedly the smallest 8-watt unit ever developed for its purpose." A gold-plated miniature plug permits rapid installation and removal. Over-all size 10¼x2⅝x3 in.—*Langevin Mfg. Corp., 37 W. 65th St., New York 23, N. Y.*

For more information circle **311** on inquiry card.

Amplifier System

New "Model 119 Amplifier System," for amplification of static and dynamic phenomena, is contained in two cases which may be arranged together or separately on bench or rack,



or fastened together. Highly-stable 5000-cps. carrier frequency, combined with high sensitivity and power output characteristics of amplifier, results in oscillographic recordings of large amplitude having a flat response from 0 (d.c.) to 1000 cps, yet requiring less than 0.5 mv. rms. input signal for full-scale output.—*Heiland Research Corp., 130 E. Fifth Ave., Denver, Colo.*

For more information circle **312** on inquiry card.

ELECTRICAL AND ELECTRONIC COMPONENTS

Germanium Diodes

New "S-C-S" line of single-crystal-stabilized germanium diodes is complete, is said to be "outstanding for long life and reliable performance . . . even under adverse conditions." Units will withstand repeated temperature and humidity cycling with no adverse effects on electrical characteristics. End plugs, which are part of internal construction, provide heat sinks to minimize danger of damage when unit is being soldered into place. Diameter is less than ¼ in.; length ½ in. Completely insulated case eliminates shorting problems. Shunt capacity 1 mmf average.—*Selenium-Intelin Dep't, Federal Telephone and Radio Co., 100 Kingsland Rd., Clifton, N. J.*

For more information circle **313** on inquiry card.

Point-contact Transistors

Two new point contact transistors: "Type OC50" designed for amplifying purposes: "Type OC51" designed primarily for switching operations. Uniformity of characteristics and reli-

.0001"

COORDINATE MEASUREMENTS CAN BE MADE DIRECT ON THE

Gaertner TOOLMAKER'S MICROSCOPE

Using Full 2" Precision Screws

This and the following features make the Toolmakers' Microscope an almost indispensable instrument in your shop or laboratory.

Range 2 x 4 inches
360° Stage Rotation
Reading to 1 minute

Protractor Circle
Range 360°
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By 2 inches
Precision Screws

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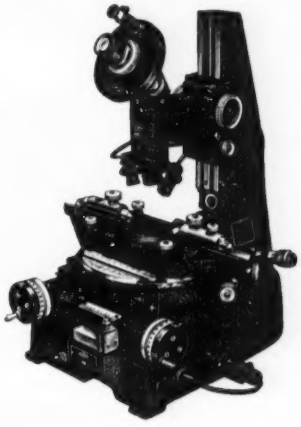
For Helix Measurement

Rugged Construction
for Many Years of
Dependable Accurate Service



For a completely illustrated book listing detailed specifications and accessories request Bulletin 147-50.

THE GAERTNER SCIENTIFIC CORPORATION

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For more information circle **86** on inquiry card.

TANK-O-METER

FOR MEASURING TANK CONTENTS ANY DISTANCE AWAY

HYDROSTATIC GAUGES

FOR ALL PURPOSES

PRESSURE • VACUUM • DRAFT
DEPTH & ABSOLUTE PRESSURE
BAROMETRIC PRESSURE
DIFFERENTIAL PRESSURE
SEND FOR BULLETINS

UEHLING INSTRUMENT CO. 466 GETTY AVE., PATERSON, N. J.

For more information circle **87** on inquiry card.

STANDARD

Radio Interference and Field Intensity

MEASURING EQUIPMENT

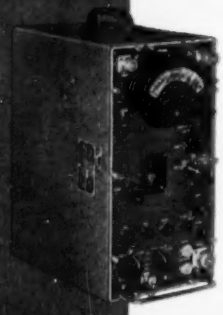
Complete Frequency Coverage—14kc to 1000 mc!

NM-10A

VLF

14kc to 250kc

Commercial Equivalent of AN/URM-6B.
Very low frequencies.

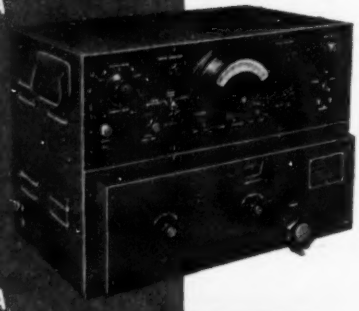


NM-20B

HF

150kc to 25mc

Commercial Equivalent of AN/PRM-1A. Self-contained batteries. A.C. supply optional. Includes standard broadcast band, radio range, WWV, and communications frequencies.



NMA-5A

VHF

15mc to 400mc

Commercial Equivalent of TS-587/U.
Frequency range includes FM and TV Bands.

NM-50A

UHF

375mc to 1000mc

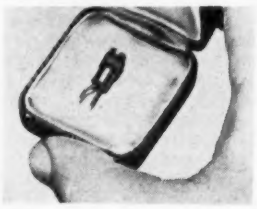
Commercial Equivalent of AN/URM-17.
Frequency range includes Citizens Band and UHF color TV Band.

These instruments comply with test equipment requirements of such radio interference specifications as MIL-I-6181, MIL-I-16910, PRO-MIL-STD-225, ASA C63.2, 16E4, AN-I-24a, AN-I-42, AN-I-27a, MIL-I-6722 and others.

STODDART AIRCRAFT RADIO Co., Inc.

6644-D Santa Monica Blvd., Hollywood 38, California • Hollywood 4-9294

For more information circle **88** on inquiry card.

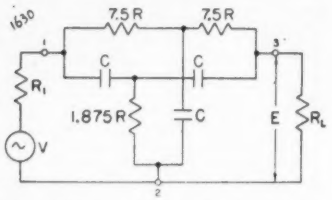


able performance are assured by extremely tight manufacturing tolerances.—*Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y.*

For more information circle **314** on inquiry card.

Twin T Networks

New "Type 501" twin-T networks are available for 30, 60, 120, 400 and 800 cps., resistance parameter values

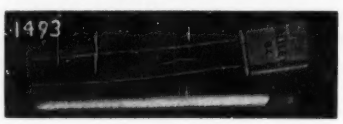


from 2500 to 40,000 ohms, and two physical sizes, making a total of nineteen types. Advantage in using these new units instead of "home-assembled" is assurance of stable components. Each network is vacuum-cast in plastic.—*White Instrument Labs., 203 Riverside Drive, Austin 4, Texas.*

For more information circle **315** on inquiry card.

Subminiature Crystal Unit

New "Bantam BX Crystal," for precision frequency control, is hermetically-sealed; range 15 to 100 Mc.;

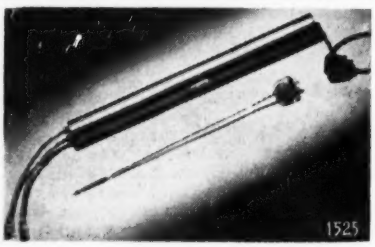


same performance characteristics as MIL types CR-23 or CR-32.; applications particularly in multi-channel communications operations; may be wired into a miniature socket or soldered to a printed-circuit terminal board.—*Bliley Electric Co., Union Station Bldg., Erie, Penna.*

For more information circle **316** on inquiry card.

Traveling-wave Tube

New "HA-2/4-50/20-1" is a broadband S-band voltage amplifier developed to provide voltage amplification from 2 to 4 kMc. which does not

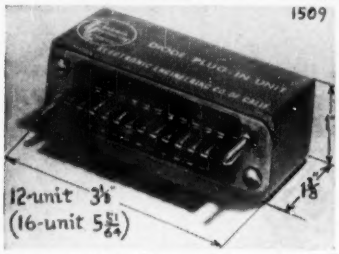


have to be tracked by a tuning voltage or mechanism. Approximate operating characteristics over this band are 40 db gain, 20 mw. output and 20 db noise figure. Unit requires a 300-gauss field and a 500-v. regulated power supply.—*Huggins Laboratories, Inc.*, 700 *Hamilton Ave., Menlo Park, Calif.*

For more information circle **317** on inquiry card.

Multi-diode Plug-in Units

New plug-in diode units, for diode matrix, mixer, computer circuits, etc., accommodate 12 or 16 germanium diodes respectively; provide a rapid



means of inserting and removing diodes from a circuit, plus advantage of having them encased in a dust-proof moisture-resistant package. Correct polarization is assured by guide pins. —*Plug-In Div., Electronic Engineering Co., of California*, 180 *S. Alvarado St., Los Angeles* 57, *Calif.*

For more information circle **318** on inquiry card.

High-temperature Magnet Wire

New line of magnet wire for Class H service or better is insulated with Teflon; has a low dielectric constant (2.0—2.05 from 60 cps. to 30,000 Mc.); is said to have a "low" loss factor and "excellent" dielectric strength. Characteristics remain stable at temperatures from –100 C. up to 260 C. Solid conductor may be either soft or annealed copper on which Teflon enamel is dip-coated; sizes from 14 to 50 AWG; six colors. Every lot tested for abrasion scrape resistance, continuity, dielectric strength and thermoplastic flow before shipping. Single, heavy, triple or quad thicknesses available.—*Hitemp Wires, Inc.*, 26 *Windsor Rd., Mineola, L.I., N. Y.*

For more information circle **319** on inquiry card.

HV LF Litz Cable

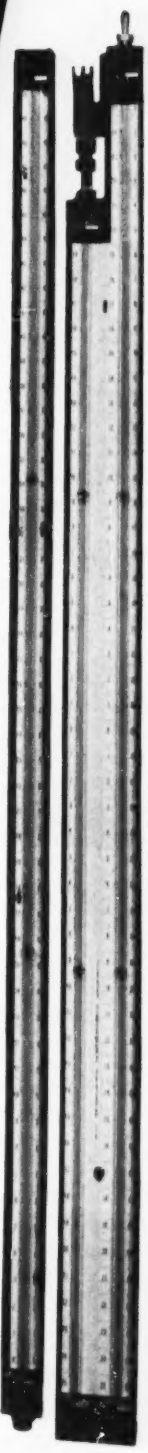
New specialized Litz cables for applications of high voltage in 20-to-400-kc. region are wound on dielectric cores of rope-like construction formed from a variety of plastic films. Core-diameter limitations of production equipment are ⅛-in. min., 2-in. max. Typical cables include copper conductors of 33 and 38 gage laid on core with a spiral of three turns per foot. A maximum of 125 multi-conductor strands can be applied.—*U. S. Plastic Rope Co.*, 2581 *Spring St., Redwood City* 10, *Calif.*

For more information circle **320** on inquiry card.

Transformers and Coils

New coils such as high frequency air core, multi-layer solenoids, peaking, synchro winding, television RF, IF, etc.; and transformers including

Buying or Selling
...*Rely on*
MERIAM
MANOMETER
ACCURACY

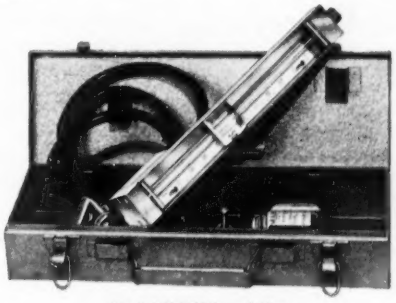


In custody transfer of valuable liquids or gases, greatest possible accuracy is required by both buyer and seller. Field measuring equipment must be precisely calibrated often. For this purpose Meriam Manometer Models B-2856 and B-2862 are extensively used.

The new, lightweight (twenty pounds) Meriam Model B-2856 Sectional U-Type Manometer in 100″ range using water offers the extreme accuracy and sensitivity required for calibration. All-aluminum construction, this model can be "broken" to 50″ length for carrying convenience. Interpolated readings to .025″water available.

The Meriam Model B-2862 Portable Field Manometer is the pioneer instrument for field calibration service. Designed with precision bore tubing, glass coated well, magnifier with anti-parallax device and a universal mounting bracket, this model in ranges up to 310″ water using mercury, offers a new high in utility and accuracy.

If you have a problem involving field calibration, drop us a line or call your Meriam Technical Representative. The Meriam Instrument Company, 10958 Madison Avenue, Cleveland 2, Ohio.

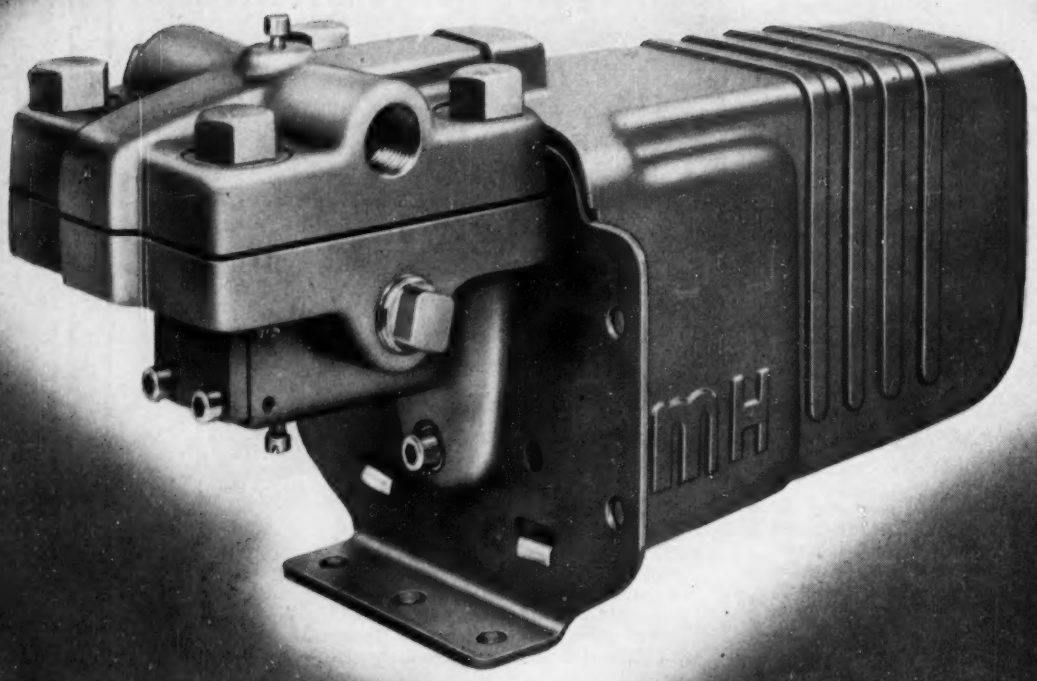


Model B-2862 and Case

Model B-2856

MERIAM Instruments
ESTABLISHED 1911
MANOMETERS, METERS AND GAUGES FOR THE ACCURATE MEASUREMENT OF PRESSURES, VACUUMS AND FLOWS OF LIQUIDS AND GASES

For more information circle **89** on inquiry card.



compare these features!

simplicity:
uses no mercury; a rugged pneumatic balance transmitter, it has few moving parts . . . needs practically no maintenance.

wide range:
readily adjustable in the field for ranges from 0–20 to 0–200 inches of water.

simple calibration:
easily calibrated with weights . . . no curves or tables needed; 1 lb. equals 10" of water.

withstands overloads:
takes many times rated pressure without loss of accuracy or damage to working parts.

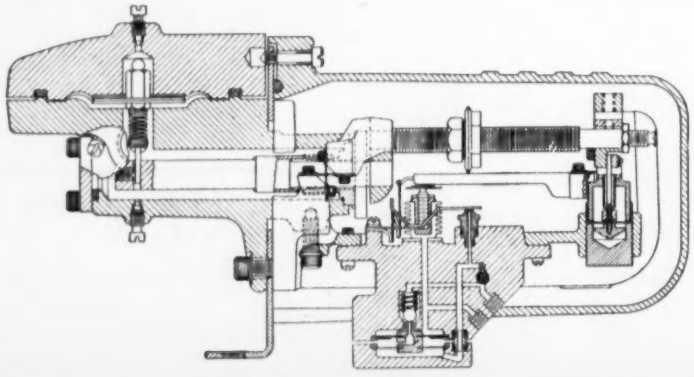
for use with miniature instruments:
converts pressure differential at the metering orifice into a proportional air pressure for transmission to remote indicators, recorders or controllers. The ideal companion for *Tel-O-Set* miniature instruments.

temperature range:
handles fluids at temperatures as high as 350° F.

versatility:
available with or without non-bleed pilot booster relay.

sensitivity:
responds rapidly to quick changes in flow.

easy installation:
lightweight, compact unit is readily mounted anywhere.



For flow measurements— the **HONEYWELL DIFFERENTIAL CONVERTER** *is better than ever*

NEW CONSTRUCTION features now make the Honeywell Differential Converter, more than ever, the standard of performance for remote measurements of flow and differential pressure.

It's more accurate than ever . . . has improved linearity of response. It's more stable, with a larger dashpot and heavier oil to smooth out spurious line fluctuations. And it's even more rugged . . . can take overloads of many times normal pressure without damage to the diaphragm or impairment of precision.

More than ten thousand Honeywell Differential Converters have been installed on an ever broadening variety of applications . . . on pipelines, in conjunction with graphic instrumentation, and in scores of other uses which need accurate, flexible remote transmission of measurements.

You can see what's behind this industry-wide acceptance, by checking the Differential Converter's outstanding features described on the opposite page. You can find out even more by testing it yourself, under any operating conditions your plant may present. And for a personal discussion of your individual process requirements, call your local Honeywell sales engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Aves., Philadelphia 44, Pa.

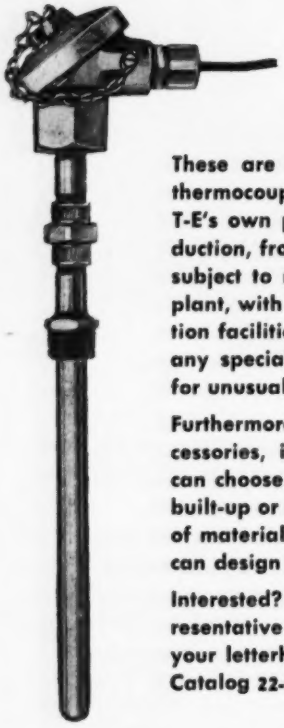
● **REFERENCE DATA: Write for new Bulletin 2290, "Honeywell Differential Converters."**

MINNEAPOLIS **Honeywell**
BROWN INSTRUMENTS
First in Controls

For more information circle **90** on inquiry card.

DOES THERMO ELECTRIC MAKE IC AND CA THERMOCOUPLES FOR HEAT-TREATING FURNACES?

YOU BET. T-E MAKES CC 'COUPLES, TOO.



These are three of T-E's many, standard thermocouples. They are manufactured in T-E's own plant, where every step in production, from calibrating to final testing, is subject to rigid quality control. This same plant, with its excellent design and production facilities, is at your service to develop any special thermocouples you may need for unusual applications.

Furthermore, T-E makes thermocouple accessories, including protection tubes. You can choose tubes from a large selection of built-up or bar stock types in a wide range of materials. If you need special tubes, T-E can design them, and produce them.

Interested? Want the name of the T-E representative nearest you? Let us know, on your letterhead. Want more data? Ask for Catalog 22-F.

Wire-type thermocouple—in all thermo elements—protection tube is mirror-polished to resist corrosion.

Tubular type, Iron Constantan thermocouple—cut-away shows welded hot junction.

Wire type, Chromel Alumel thermocouple—protection tube has open cold end to maintain oxidizing atmosphere.

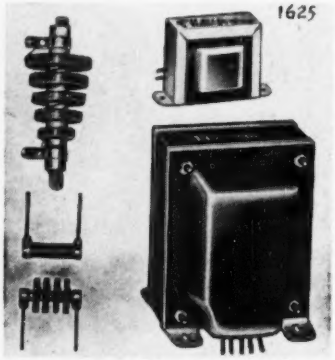
Pyrometers • Thermocouples • Protection Tubes • Quick-Coupling Connectors
Thermocouple and Extension Wires • Resistance Bulbs • Connector Panels

Thermo Electric Co., Inc.

SADDLE RIVER TOWNSHIP, ROCHELLE PARK POST OFFICE, NEW JERSEY
IN CANADA—THERMO ELECTRIC (Canada) Ltd., BRAMPTON, ONTARIO

For more information circle **91** on inquiry card.

NEW INSTRUMENTS

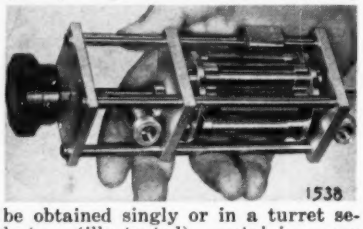


audio, power, high voltage, pulse applications, synchros, etc.; are being made in short runs to user's specifications. Where only a few (or even one) samples are required for experimental work, requisition is readily accommodated.—*Transformer and Coil Mfg. Div., Transvision, Inc., New Rochelle, N. Y.*

For more information circle **321** on inquiry card.

Coaxial Attenuators

New complete line of coaxial attenuators from 0.1 db to 60 db, with a frequency range of d.c. to 3000 Mc., may

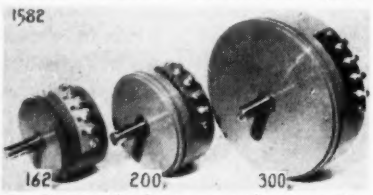


be obtained singly or in a turret selector (illustrated) containing any six values of attenuation, featuring a "Pull-Turn-Push" selection sequence. —*Stoddard Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif.*

For more information circle **322** on inquiry card.

Precision VDRs

New "Model 200" (1.990-in. diam.) and "Model 300" (2.990-in. diam.) are added to maker's "Model 162" (1⅝-



in. diam.) single-turn continuous-rotation precision voltage-dividing resistor in order to make still closer linearities and accuracies available to computer, servo and airborne instrument fields. For "Model 300," linearity tolerance is 0.075 percent of total resistance for most values; max. resistance 260,000 ohms; power rating 5 watts; service life exceeds a million cycles for speeds up to 100 rpm. Any number of units can be ganged on one shaft.—*George Rattray & Co., Inc., 116-08 Myrtle Ave., Richmond Hill 18, N. Y.*

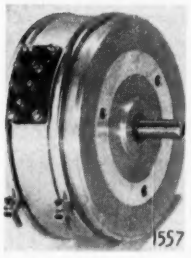
For more information circle **323** on inquiry card.

Precision VDR

New "J Series Helipot" is a 2-in. single-turn, continuous-rotation precision voltage-dividing resistor for servo mounting. Resistance from 2 ohms to 100,000 ohms with tolerance as close as 1 percent. Linearity tolerance of 0.25 percent can be achieved in resistances below 10,000 ohms, and 0.15 percent for 10,000 ohms and above. Power rating 4 watts at 40 C. ambient. Up to 21 extra taps, each spot-welded to a single turn without shorting out adjacent turns. Up to six sections can be ganged; over-all length is 1-19/32 in. for one section; each additional section adds 39/64 in. to the over-all length. External metal clamps permit rapid phasing of any section, even after installation. Choice of precision miniature ball bearings or sleeve bearings.—*Helipot Corp., 916 Meridian Ave., South Pasadena, Calif.*

For more information circle **324** on inquiry card.

Sine-cosine VDR



New "Type 753" is a 3-in. continuous sine-cosine voltage-dividing resistor with two wipers spaced 90 deg. apart to furnish full function sine-cosine outputs; is also available for straight sine function with a single wiper; is easily ganged to 6 cups. Standard resistance value 20,000 ohms per quadrant. Standard linearity tolerance 0.5 percent of peak-to-peak output. Torque per cup section 1.5 oz.-in. for single wiper and 2.0 oz.-in. for dual wiper at 25 C. All terminals gold-plated.—*Potentiometer Div., Fairchild Camera and Instrument Corp., Hicksville, N. Y.*

For more information circle **325** on inquiry card.

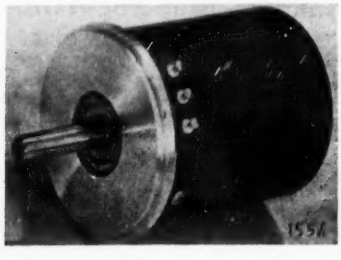
Servo-mounting VDR

New "Type RVP⅞ Miniature Precision Potentiometer," ⅞-in. dia., is furnished with a precision servo type mounting for motor or gear-driven applications where precise mechanical mounting dimensions are required. Units may be ganged using stainless steel clamp rings which permit precise phasing among sections by user. New "RVP⅞" is similar in all other respects to maker's "RV⅞" precision voltage divider.—*Technology Instrument Corp., 531 Main St., Acton, Mass.*

For more information circle **326** on inquiry card.

Helical VDR

New "Type 745" 10-turn helical type voltage-dividing resistor, for precision applications such as speed com-



Output from this rugged Genisco Accelerometer

(GLH MODELS)

is measured in volts ... not millivolts!

minimizes need for amplifying devices!

IMPORTANT GLH PERFORMANCE CHARACTERISTICS

Damping Factor: Instruments up to ±7.5 G's inclusive can be damped .4 to .6 critical; ±7.5 G's to ±10 G incl. .35 to .55 critical; above 10 G's .3 to .5 critical.

Range: ±2 G's to ±30 G's; zero acceleration at midpoint.

Natural Frequencies: 6 to 23 cps. (depending upon range).

Potentiometer Resistance: From 1000 to 10,000.

Resolution: Normally from .25 to .3%, depending upon resistance requirements.

Steady State Acceleration: Can withstand 75 G's in all planes without damage; somewhat less along sensitive axis in low range units.

Linearity: ±0.5% of best straight line through calibration points.

Resistance to shock: 40 G's in any lateral direction; shock loads in 2 directions, equal to range, without damage.

Crosstalk error: Less than 1% change caused by lateral acceleration equivalent to total range of instrument.

Weight: 2 to 2¼ lbs., depending on "G" range.

Overall Physical Size: 3¼"x3⅛"x 2⅝".

Static Friction: .075 G max. up to and including ±7.5 G's,

0.5% full scale output above ±7.5 G's.

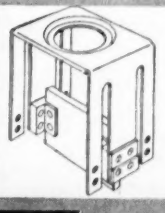
(special modifications for higher natural frequencies and greater damping can be supplied.)

A precision built potentiometer is the secret behind the high output of Genisco's GLH Accelerometer

As much as 50 volts can be put across the potentiometer of the standard GLH, and up to 72 volts on special models. Since the wiper scans the full voltage range, use of the GLH eliminates the need for amplifying devices in many guided missile control and flight test applications.

Keeping the resistance winding free from foreign materials during assembly, careful adjustment of the wiper pressure to precise tolerances, and hermetic sealing of the instrument in inert gas result in electrical output noise so low it can be considered negligible—over a life span in excess of 4 million cycles.

Complete specifications and prices on the GLH are available from Genisco, Inc., 2233 Federal Ave., Los Angeles 64, California. Write today.



A parallelogram suspension confines the mass of the GLH to a virtual straight line motion and provides excellent lateral rigidity.

Genisco INCORPORATED

Other accelerometer models also available! Write today for information on Genisco's new GMO miniature potentiometer-type accelerometer (weighs only 7 ounces), the new tapped-potentiometer-type accelerometers, and the new DDL Dual-Damped (oil and magnet) accelerometers. Prompt deliveries on all models.

For more information circle **92** on inquiry card.

Simplify
INSTRUMENT
TUBING
INSTALLATION AND
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Use
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...the standard
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INSTRUMENT TUBING
support.

Now, you can simply and quickly assemble and erect a light but strong mechanical protection and continuous support for instrument tubing in new or old construction. Instrof, a proved system of prefabricated steel trough and fittings, is the modern, economical answer to this need. It is so versatile in application that with the use of standard fittings, changes in direction and elevation are made without difficulty.

Assembly requires only the use of nuts and bolts which are supplied. Complete Instrof system is hot dip galvanized for long life with minimum maintenance.

Experienced Instrof engineers will gladly assist in planning your installation. For full details write for Bulletin 3-I.

and other necessary fittings

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INCORPORATED
4923 PENTRIDGE ST.
PHILADELPHIA 43, PA.

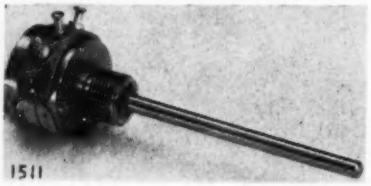
For more information circle **93** on inquiry card.

puters, guided missile controls, etc., has a resistance range of 100 to 300,000 ohms; linearity tolerances 0.025 percent 5000 ohms and over and 0.05 percent under 5000 ohms. It meets environment and performance tests under JAN-R-19 and under applicable requirements of MIL-E-5400, and fungus resistance tests under MIL-E-5272A. Terminals are gold plated. "Type 745" weighs 7 oz. and is 2 in. in diameter at servo flange. It dissipates 5 watts at 40 C. and has a starting torque of 1 oz.-in. Mechanical and electrical rotation 3600 plus 2 minus 0 deg.—*Potentiometer Div., Fairchild Camera and Instrument Corp., Hicksville, N. Y.*

For more information circle **327** on inquiry card.

Metallic-film VDR

New "Type 771 FilmPot," said to be the first metallic-film-type voltage-dividing resistor on commercial mar-



ket, is for semi-precision applications where infinite resolution, high temperature operation, high wattage dissipation, and wide resistance range in a small size unit are called for. It has a resistance element of precious metal deposited on an inorganic substrate which is electrically stable up to 225 C. This element assures a low temperature coefficient of resistance over a range of 100 to 200,000 ohms in ¾-in. case size. Deliveries now are for sample orders being produced to target specifications for customer engineering evaluation.—*Potentiometer Div., Fairchild Camera and Instrument Corp., 225 Park Ave., Hicksville, L. I., N. Y.*

For more information circle **328** on inquiry card.

Internal-clamp-ring VDR

New "Type 741 Potentiometer" features internal clamp rings which make it gangable without increasing its over-all diameter of 1⅛ in. Available in medium resistance ranges; linearity 0.5 percent or better; standard electrical rotation angle of 350 deg.; mechanical rotation continuous; gold-plated terminals; ⅛-in. diam. shaft.—*Potentiometer Div., Fairchild Camera and Instrument Corp., Hicks-Ville, L. I., N. Y.*

For more information circle **329** on inquiry card.

Internal-clamp-ring VDR

New "Type 754" is the second in a series of linear-function voltage dividers featuring internal clamp bands which permit ganging up to 8 units on a single shaft giving a smooth unbroken exterior surface 1.99 in. in diameter. Linearity is 0.15 percent standard, 0.1 percent special. Resolution 0.03 percent max. Resistance range 800 to 100,000 ohms standard; nominal effective electrical angle

356±0.5 deg.; power rating 5 watts per single cup section. Units normally supplied with servo-flange mounting. —*Potentiometer Div., Fairchild Camera and Instrument Corp., Hicksville, N. Y.*

For more information circle **330** on inquiry card.

Power Resistor

New "Series C8JJ" 15-watt resistor is added to "Greennohm Jr." line of power resistors with sealed ceramic casings containing wire-wound resistance elements. Axial pigtail leads are 1½-in.-long No. 20 tinned copper wire. New 15-watt unit is 2 in. long by ½ in. diam.—*Clarostat Mfg. Co., Inc., Dover, N. H.*

For more information circle **331** on inquiry card.

Subminiature Resistor

New "NM-2" subminiature wire wound resistor, appropriately titled "The Runt," measures ¼-in. x ¼-in.; is available in values up to 60 k., 0.1 percent; is hermetically sealed; will withstand rugged environmental conditions.—*Eastern Precision Resistor Corp.*, 130 - 11 - 90*th Ave., Richmond Hill* 18, *L. I., N. Y.*

For more information circle **332** on inquiry card.

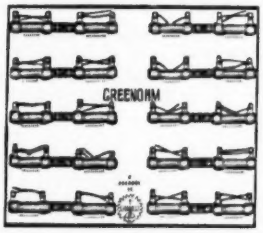
Sealed Resistors

New "Type P" light-weight encapsulated wire-wound resistors are available in eleven new styles, in all lug-type MIL-R-93A styles as well as in five axial lead types including several that conform to MIL-R-93A, Style RB52. Ratings to 3.5 watts at 125 C. operation. In typical qualification approval tests, these resistors withstood 24 temperature cycles from −65 C. to 100 C. as compared to the 5 cycles between −55 C. and 85 C. required by MIL-R-93A.—*Shallcross Mfg. Co., Collingdale, Penna.*

For more information circle **333** on inquiry card.

Power Resistor Kit

New "Greenohm Fixed Wire-wound 10-watt Power Resistor Kit" consists of 20 fixed wire-wound resistors of



popular ohmages, so mounted that as resistors are removed, ohmage of particular resistor appears on board. —*Distributor Div., Clarostat Mfg. Co., Inc., Dover, N. H.*

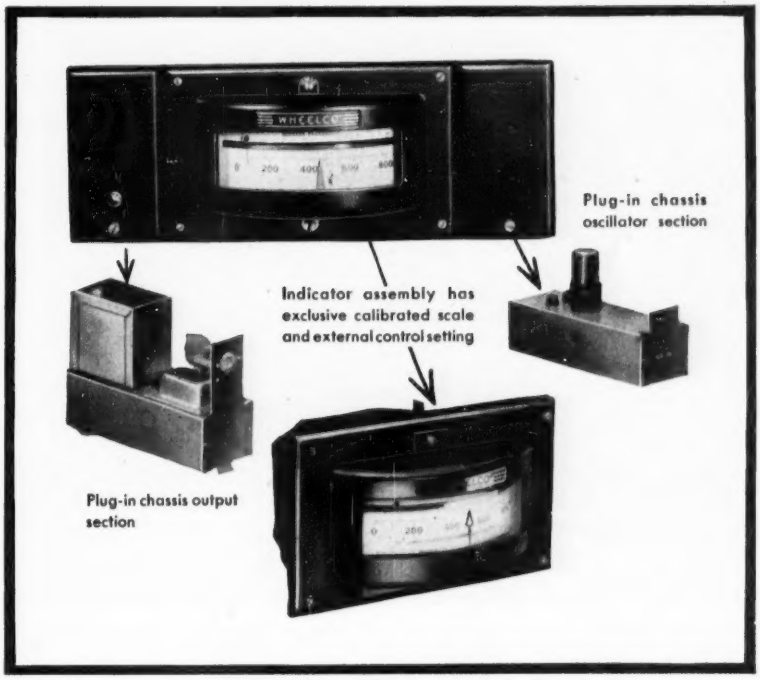
For more information circle **334** on inquiry card.

Encapsulated Resistors with 0.05-percent Accuracy

New "Super Davohm Encapsulated Seald-Ohm Resistors" use air to keep molding material separated from resistance wire, which is maintained in a slot filled with dry air. Air pockets between wire and plastic coating guarantee stability and prevent shorted turns. Molding compound, ceramic

BARBER COLMAN

Wheelco Controllers


Plug-in chassis oscillator section
Indicator assembly has exclusive calibrated scale and external control setting
Plug-in chassis output section

"unit construction" helps keep your maintenance costs lower

Wheelco Capacitrols take the gamble out of instruments for precise control of voltage, current, speed and other process variables.

Plug-in assemblies simplify and speed adjustment. All parts are easy to check and inspect. Capacitrols have no complicated components. Replacement parts inventory is always at a minimum.

With economical periodic service from Wheelco's nationwide engineering staff . . . your instrument worries will be over when you standardize on Wheelco. Write for Capacitrol Bulletin PC-2.

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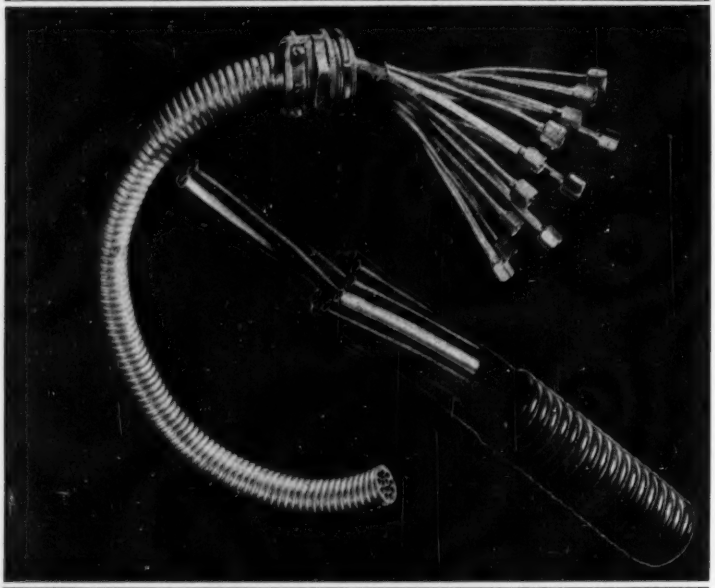
Industrial Instruments • Automatic Controls • Air Distribution Products • Aircraft Controls • Small Motors
OVERdoors and Operators • Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

For more information circle **94** on inquiry card.

CRESCENT



ARMORED MULTITUBE

Licensed under U. S. Patent 2,578,280

For use with instruments and process control equipment

Here is a new way to make substantial savings on moderate to long runs on 1/4", 5/16", 3/8", and 1/2" O. D. tubes.

CRESCENT ARMORED MULTITUBE is an armored group of long length tubes twisted together to permit bending without any distortion of the tubes, which are thoroughly protected from injury during and after installation by a flexible, interlocked galvanized steel armor.

One tube in each layer has a bright blue color, which permits a ready identification of each tube at both ends. This is a real time-saving feature as the installers can connect both ends without the necessity for tracing through each tube. The position of each tube in each layer, with respect to the color-coated tube in that layer, remains the same throughou any length of ARMORED MULTITUBE.

Long, continuous lengths up to 1,000 ft. save waste and short ends. Tubes are available in copper, aluminum, polyethylene and other plastics.

SEND FOR BULLETIN GIVING COMPLETE INFORMATION AND ENGINEERING DATA

CRESCENT
Insulated Wire & Cable Co.
TRENTON 5, N. J.

For more information circle 95 on inquiry card.

bobbin, resistance wire, and metal terminals, all have the same temperature coefficient of expansion; hence no possibility of cracks or strains on wire during cycling. Because of this construction, maker can furnish units with temperature coefficients below 20 ppm./deg. C. and with accuracies to 0.05 percent.—*The Daven Co.*, 179 *Central Ave., Newark* 4, *N. J.*

For more information circle **335** on inquiry card.

Borocarbon Resistors

New "Filmite B Series, Types 4E, 5E and 6E" molded borocarbon resistors are said to be the first to meet the performance requirements of MIL-R-10509A, Proposed Modification 2. Rated at ½, 1 and 2 watts, units will dissipate full-rating wattages at an ambient of 70 C. compared with 40 C. ratings on previous resistors of this type. Dense plastic material gives mechanical molding protection to borocarbon film and serves as a barrier for moisture and vapor. Low-contact-resistance low-noise end terminations are held rigidly in place on ceramic cores; extremely low temperature and voltage coefficients of resistance; excellent load-life and h-f. characteristics.—*Sprague Electric Co.*, 43 *Marshall St., North Adams, Mass.*

For more information circle **336** on inquiry card.

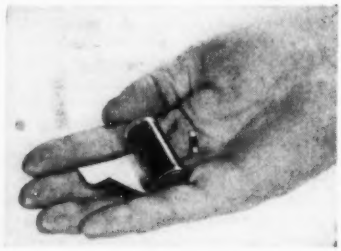
Climatized Resistors

New units of "Welwyn High Stability Deposited Carbon Resistors" will be furnished with black "panclimatic" coating. Advantages of this new coating are said to be: Complete reliability from –90 F. to 300 F.; moisture protection; storage stability of better than 1 percent; stability better than 1 percent at 212 F. ambient at 50 percent nominal rating; resists abrasion and impact with no "tackiness"; chemically inert to common solvents and plasticizers.—*Rockbar Corp.*, 215 *E. 37th St., New York* 16, *N. Y.*

For more information circle **337** on inquiry card.

Tape Resistors

New tape resistors for printed circuits are available in resistance values from 100 ohms to 10 megohms, either as cured ready-to-use ¼-watt resistors



½ in. long, ⅛ in. wide and 0.01 in. thick, or as uncut uncured tape rolls. They conform to all JAN-R-11 specs. They are suitable for semi-automatic applications in which a single operation (less than one second) fastens them to chassis and connects them into circuit.—*Sanders Associates, Inc.*, 137 *Canal St., Nashua, N. H.*

For more information circle **338** on inquiry card.

Hundred-million-megohm Carbon-coating Resistors

New "Type H High Megohm Resistors," with resistance values up to 100 million megohms, are said to give excellent results when used in electrometer and photocell circuits and as high resistance standards in measurement equipment. Essentially a carbon coating on a steatite rod. Extremely low voltage coefficient of resistance. Lengths 1, 1¾ and 3 in.—*Resistance Products Co.*, 714 *Race St., Harrisburg, Penna.*

For more information circle **339** on inquiry card.

30-kv. Ceramic Capacitors

New molded ceramic units extend range of high-voltage filter capacitors to 30,000 v.dc., for TV receivers, cathode-ray instruments, etc. Units are available with fifteen different terminal combinations. Standard rated capacitance 500 mmf.; max. operating temp. 85 C.; minimum insulation resistance under standard test procedures at 25 C. is 10,000 megohms.—*Sprague Electric Co.*, 199 *Marshall St., North Adams, Mass.*

For more information circle **340** on inquiry card.

Paper Capacitors

New "Tropicaps," molded tubular paper capacitors, distinguished by their emerald green color, have been designed for superior resistance to extreme humidity; will withstand severe mechanical and thermal shock, and total immersion. They are nonflammable; will operate at 1½ times rated voltage for 250 hours at 85 C. Units available in all standard capacitance and voltage ratings.—*Micamold Radio Corp.*, 1087 *Flushing Ave., Brooklyn, N. Y.*

For more information circle **341** on inquiry card.

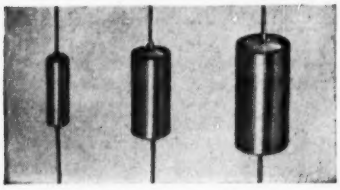
Tantalum Foil Capacitors

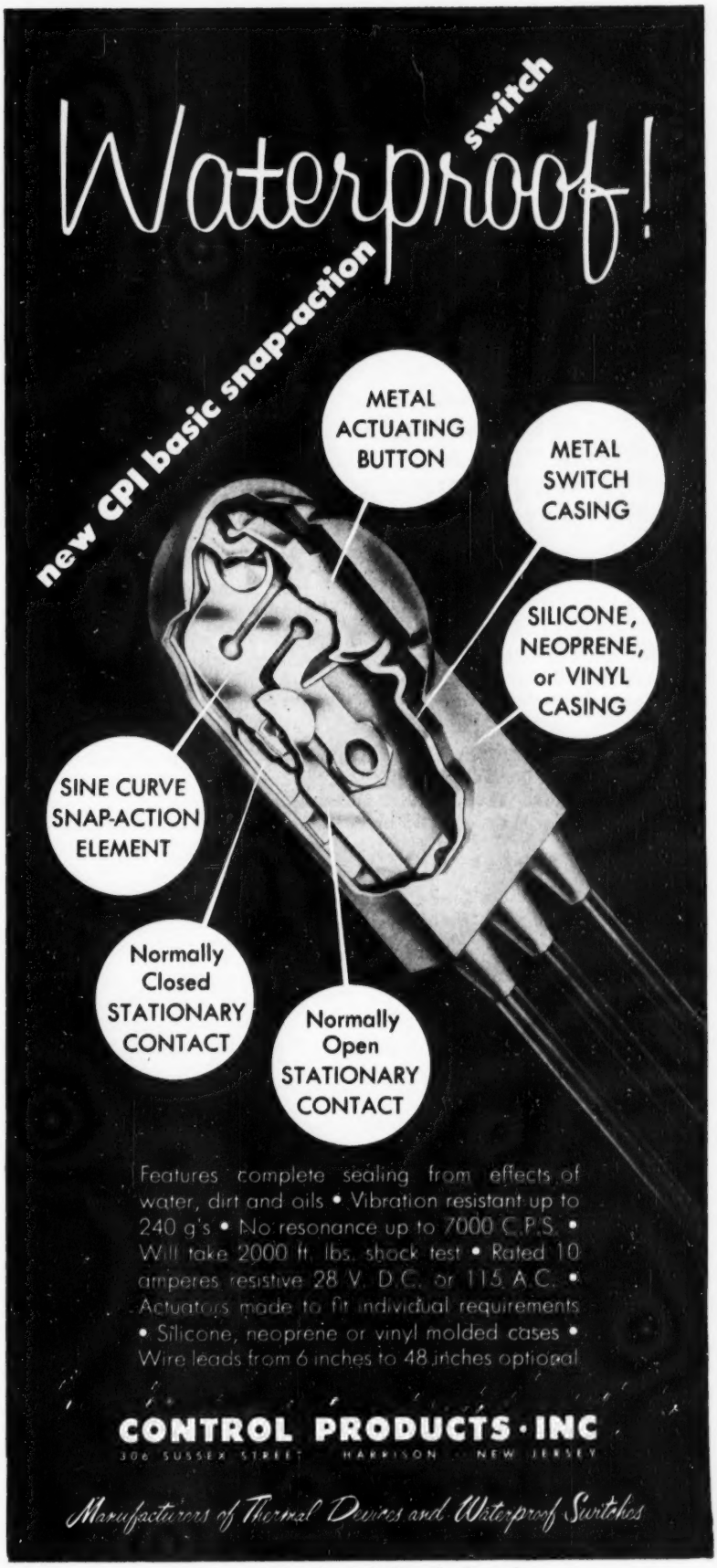
New Tantalum Foil Electrolytic Capacitors are said to be "phenomenally compact" subminiature units 9/16 in. long and 3/16 in. diam.; especially well suited for application in transistor circuits, etc. Operating temperature range –55 C. to 85 C.; considerably lower leakage current than other electrolytic types, hence extended service life and exceptionally long shelf-life. Thirty-five units available in capacitances from 0.01 ufd. to 8.0 ufd. and from 3 w.v.d.c. to 150 w.v.d.c. in both polarized and nonpolarized types.—*Cornell-Dubilier Electric Corp., South Plainfield, N. J.*

For more information circle **342** on inquiry card.

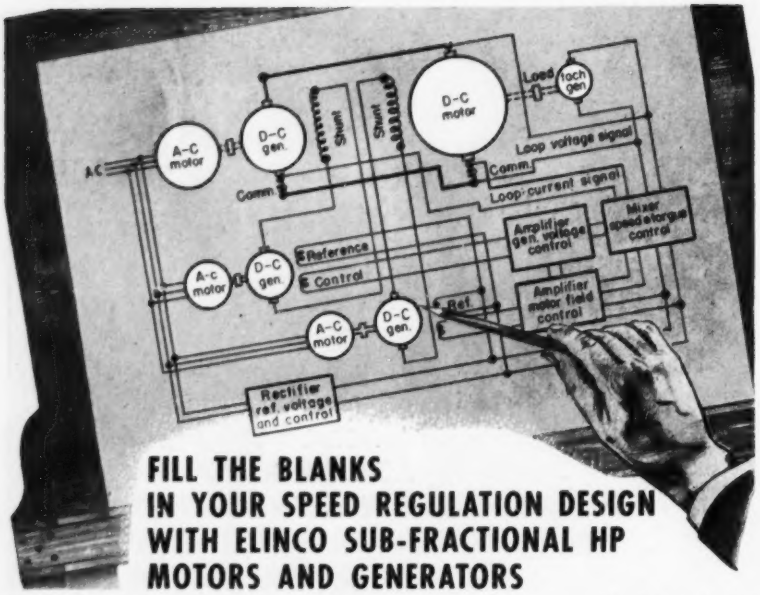
Miniaturized Capacitor

New "Type TI" capacitors display exceptional stability between temperature extremes: capacitance variance is less than 5 percent from —80 C. to 200 C. Capacitance is substantially




Waterproof! switch
new CPI basic snap-action
METAL ACTUATING BUTTON
METAL SWITCH CASING
SILICONE, NEOPRENE, or VINYL CASING
SINE CURVE SNAP-ACTION ELEMENT
Normally Closed STATIONARY CONTACT
Normally Open STATIONARY CONTACT
Features complete sealing from effects of water, dirt and oils • Vibration resistant up to 240 g's • No resonance up to 7000 C.P.S. • Will take 2000 ft. lbs. shock test • Rated 10 amperes resistive 28 V. D.C. or 115 A.C. • Actuators made to fit individual requirements • Silicone, neoprene or vinyl molded cases • Wire leads from 6 inches to 48 inches optional
CONTROL PRODUCTS · INC
306 SUSSEX STREET HARRISON NEW JERSEY
Manufacturers of Thermal Devices and Waterproof Switches

For more information circle **96** on inquiry card.



FILL THE BLANKS IN YOUR SPEED REGULATION DESIGN WITH ELINCO SUB-FRACTIONAL HP MOTORS AND GENERATORS

Elinco designs and manufactures hundreds of variations of sub-fractional horsepower motors and generators to solve accurately nearly *ANY* specific problem, virtually *ANY* specific requirement, called for by your instrument design.

All Elinco units feature instrument-type precision ball bearings. Every unit is balanced dynamically . . . individually tested under specific load conditions. Step-by-step inspection of every component — assures high-precision on *ALL* parts.

Hundreds of variations on over 650 basic models of sub-fractional horsepower motors and generators engineered by ELINCO in the last 25 years are at your disposal. We may have already solved your instrument problem. If not, we will design and manufacture motors and generators incorporating any physical or electrical variation to meet your specific requirements.

Take advantage of Elinco's experience to solve your special instrument problem. See ELINCO for high precision sub-fractional horsepower motors and generators, 1/3000 to 1/6 hp, built to your specifications.

But please outline your problem in *full* detail when requesting quotations or literature. We have NO STOCK UNITS, no "mass-produced" units available. Every ELINCO unit is a precision instrument, specially designed and manufactured to meet your highest specific performance standards.

ELINCO MOTORS & GENERATORS

Ratings:	1/3000 to 1/6 hp
Types:	AC • DC • Universal • Servo • Self-Synchronous
Phases:	One-, two-, and three-phase
Windings:	Compound • Shunt • Series • Separately Excited Split Field • Permanent Magnet • Reluctance Hysteresis • Stabilized Hysteresis Induction • Drag Cup
Services:	1-, 2-, 3-, & 5-speed synchronous AC Dynamically Braked • Adjustable Speed Governor Controlled • Self-Starting • Reversible
Frames:	Available in all regular frame types or specially designed according to specifications

Over A Quarter Century Of Precision Manufacturing

ELINCO **ELECTRIC INDICATOR COMPANY, INC.**

106 Camp Avenue • Springdale • Conn.

For more information circle **97** on inquiry card.

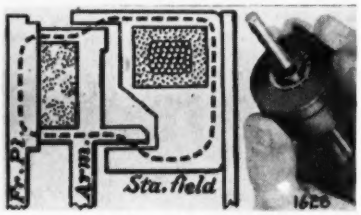
unaffected by frequency; has a dissipation factor less than 0.0008. Units are hermetically sealed with 100-percent tin-coated glass-kovar end seals. Prompt delivery in complete RTMA capacitance series.—*National Capacitor Co., 385 Washington St., Quincy, Mass.*

For more information circle **343** on inquiry card.

ELECTROMECHANICAL COMPONENTS

Electric Clutches, Brakes

New line of electric clutches and brakes for instrumentation (rather than machinery) operate on 6 to 15



watts; diameters 1.81, 2.63 and 4.25 in.; static torques 8, 60 and 240 lb.-in.; approx. speed ratings 10,000, 7200 and 4500 rpm.; standard coils for 6, 12, 28, 40 and 90 v.dc.—*Warner Electric Brake and Clutch Co., Beloit, Wis.*

For more information circle **344** on inquiry card.

400-cps. Servomotor

New "Model 172" 400-cps. two-phase low-inertia motor meets all applicable environmental and operational military specs; features high torque-to-inertia ratio: stall torque 2.7 in.-oz., rotor inertia 3.3 g.cm.^{2}; no-load speed 9000 rpm.; no-load power input 4 watts; stall power input 8 watts. Unit measures 1.75 in. diam. by 2.69 in. over-all length; weighs 11 oz.—*American Electronic Mfg., Inc., 9503 W. Jefferson Blvd., Culver City, Calif.*

For more information circle **345** on inquiry card.

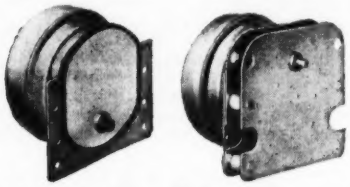
Servomotor

New "Type 52 Servo Motor," 1½-in. diam., is available in various speeds and electrical characteristics; principally for 60- and 400-cps. circuits; can be supplied to meet rigid military specifications with regard to humidity, temperature, vibration and altitude. Stator is completely embedded in an insulating compound of extreme dielectric strength, high temperature stability, and low temperature coefficient of expansion. Choice of stainless steel or aluminum housings and stainless steel or SAE 52100 steel ball bearings.—*Dep't R, G-M Laboratories Inc., 4300 North Knox Ave., Chicago 41, Ill.*

For more information circle **346** on inquiry card.

Miniature Timing Motors

New line of miniature timing motors is for industrial use: temperature and pressure recorders, dryers,

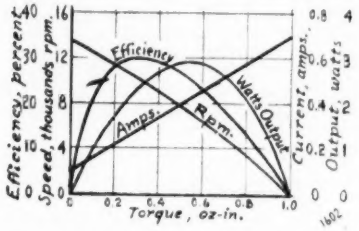


defrosters, time switches, stoker and oil burner controls, thermostats, x-ray timers, etc. Use of nylon gear-pinion assemblies is said to be "an industrial 'first'." Also use of "Lubricone." New units are available in output speeds from 450 r.p.m. to 1 rev. in 31 days. Special switching mechanisms available.—*Industrial Movement Sales Div., Sessions Clock Co., Forestville, Conn.*

For more information circle **347** on Inquiry card.

Miniature PM Motor

New "Type SS Moto Mite" is a miniaturized permanent-magnet d-c. motor ⅞-in. diam. by 1⅜-in. long;

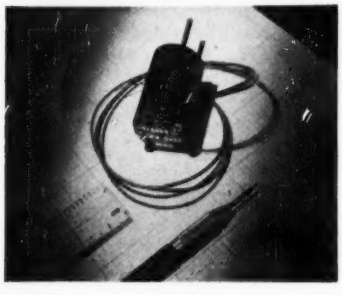


weight 2 oz.; stall torque 1 oz.-in. and no-load speed 14,000 rpm. with standard 27-v.d.c. winding; other windings available for different voltages, speeds and torques. Unit meets all military specs; can be furnished with r-f. filter, various spur gear reducers, or fan or blower elements.—*Globe Industries, Inc., P. O. Box* 101 *North Dayton Station, Dayton, Ohio.*

For more information circle **348** on inquiry card.

Miniature PM Motor

New "Type PM-47" miniature permanent-magnet motor, rated at 1/400 hp. with operating rotor speed of 10,500 rpm., is designed for continuous duty; draws 0.18 amp. at 27 v.dc.; weighs 5 oz. Dimensions are 1 13/16 in. long by 1¼ in. diam. and ⅛-in. shaft with 1 1/16-in. extension length; other lengths and arrangements including splines, keyways, gears, etc., can be provided. Various types of



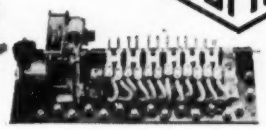
Here are 3 PROVEN ANSWERS to your timing problems

1

AEMCO AUTOMATIC RESET TIMER

Opens or closes circuits for intervals of seconds or hours, recycling immediately or holding a circuit for a fixed interval before recycling. Stock models available with fixed or adjustable settings. In case of current interruption unit will recycle or hold position and recycle with return of current.

2



AEMCO SEQUENCE TIMER

Engineered to meet requirements for the individual timing of a series of operations. All circuits are 15 amp., have positive quick make and break pure silver contacts. Friction clutch between cam shaft and motor gear train may be manually adjusted at any time desired. Automatic Sequence Timers may be supplied in SPST or SPDT . . . are carefully engineered to meet exacting specifications.

3

AEMCO CYCLE MASTER

This low-cost Automatic Time Switch can be set for as many as 48 ON and OFF operations per revolution of the dial. Unit has a 15 minute minimum ON or OFF interval on 24 hour cycle unit . . . 7½ minute interval on 12 hour cycle models and as little as 37½ second intervals on 1 hour cycling models. All models will control up to 48 ON and OFF operations during cycle. Available with Sunday and holiday cutout in 10 or 20 amp. capacity . . . four to eight terminal panel.

AEMCO ENGINEERED RELAYS

AEMCO also manufactures a complete line of quality relays . . . open and sealed type, midgets and miniatures . . . plug-in base or specialized mountings . . . an almost limitless variety of spring and coil combinations. AEMCO Relays exceed specs . . . *military or industrial!* Specialized units engineered and manufactured to meet particular requirements and specifications.

Why not write us today? The services of our skilled engineering staff are at your disposal.

AEMCO Automatic Electric MFG. CO.

58 STATE STREET · MANKATO, MINN.

For more information circle **98** on inquiry card.

Heiland

Subminiature Galvanometer

20th Anniversary Model

• In the past 20 years Heiland Research Corporation has made many contributions toward increasing the dependability and accuracy of recording oscillographs and oscillograph galvanometers.

• At the same time, the versatility of these instruments has increased to encompass an ever-widening field of applications in research and industry.

• On our 20th anniversary we take pride in announcing a new subminiature galvanometer which will be on exhibit at—

Booth 290 Instruments Avenue

I.R.E. Show

KINGSBRIDGE ARMORY • NEW YORK CITY

March 22-25

—at which time details concerning specifications and performance characteristics of our new galvanometer will be released.

Heiland Research Corporation

130 EAST FIFTH AVENUE • DENVER COLORADO

For more information circle 99 on inquiry card.

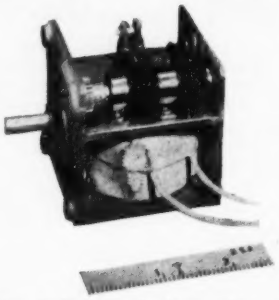
NEW INSTRUMENTS

electrical connections (integral-lead type illustrated) can be provided.—*Dalmotor Co., 1375 Clay St., Santa Clara, Calif.*

For more information circle **349** on inquiry card.

High-starting-torque Motor

New electric motor features low-speed high-starting-torque for aircraft actuators, remote-controlled rheostats, indexing devices, etc.; operates efficiently over a wide range of frequencies as well as pulsating d.c. Starting torque is equal to running torque, with instantaneous stopping when power is turned off. Units are available delivering over 6 inch-pounds of torque at 30 rpm. and operating satisfactorily over a temperature range of –60 F. to 500 F.—*The Viking Tool & Machine Corp., 2 Main Street, Belleville 9, N. J.*



For more information circle **350** on inquiry card.

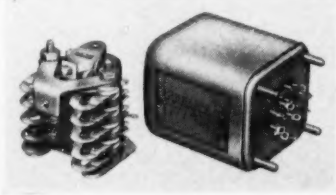
Motor-control Relay

New "Class 8505 Type C Magnetic Relay" is 50-amp. s-p. n-c. type for use with single-phase capacitor start motors requiring a voltage-sensitive relay to disconnect start winding or reduce capacitance when motor approaches full speed. Clapper-type magnet is designed with a permanent air gap, a knife-edge bearing, ground sealing surfaces and a heavy shading coil, for long life and quiet operation. Double-break silver-to-silver contacts will handle start winding currents up to 50 amps. (115-v.) and 35 amps. (230-v.). Magnet coils are available for continuous duty ratings up to 480 v. 60 cps. or 300 v. 25 cps. Relay pull-in voltage adjusted at factory for operation within desired range.—*Square D Co., 4041 N. Richards St., Milwaukee, Wis.*

For more information circle **351** on inquiry card.

Severe-service Relays

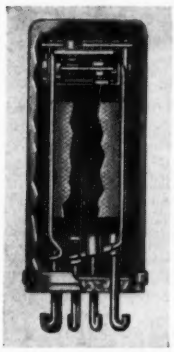
New "Hi-G" power relays for high temperature, shock, and vibration service in military aircraft, rockets,



and guided missiles, are securely braced to hermetically-sealed containers and constructed of non-volatile materials that cannot cause explosion hazards. Four basic series: high-*G* types that withstand 20 *G* vibration at over 500 cps.; standard types for 10 *G* vibration at 55 cps.; special high-temperature types; and industrial types for less severe applications. All are available with 2-, 3-, and 4-pole d-t. or s-t., or 6-p.s-t. Contact ratings of 3, 5, or 10 amps. On life tests, relays operated for over 2,000,000 cycles making and breaking rated load. All types operate at temperatures up to 325 F.; specials at 600 F.—*Hetherington, Inc., Sharon Hill, Penna.*

For more information circle **352** on inquiry card.

Miniature Relay

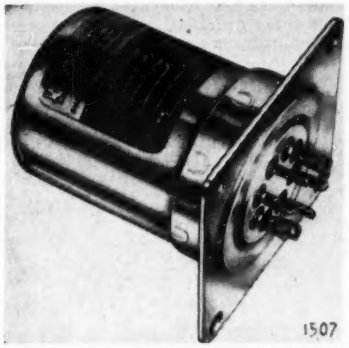


New "PW" miniature d-c.-actuated hermetically-sealed relay with ruggedized balanced armature construction (shown actual size) withstands 10*G* vibration up to 500 cps. during operation. High-permeability low-residual nickel-iron magnetic structure gives high sensitivity and contact pressure said to be previously unobtainable in a sensitive relay of this size. Pure silver s-p.d-t. contacts are rated 2 amps. 28 v.dc. or 115 v.ac. non-inductive load; coils from 100 to 16,000 ohms; actuation, current or voltage; operating power, 25 milliwatts to 1.5 watt.—*Potter & Brumfield, Princeton, Indiana.*

For more information circle **353** on inquiry card.

Miniature Relay

New "Model 2001" miniature 10-amp. d-p.d-t. relay features vibration immunity exceeding military specifications; coil resistance up to 80,000 ohms; range 50 milliwatts to 2 watts. Prompt delivery.—*Electro-Mechanical Specialty Co., Inc., 6819 Melrose Ave., Los Angeles 38, Calif.*

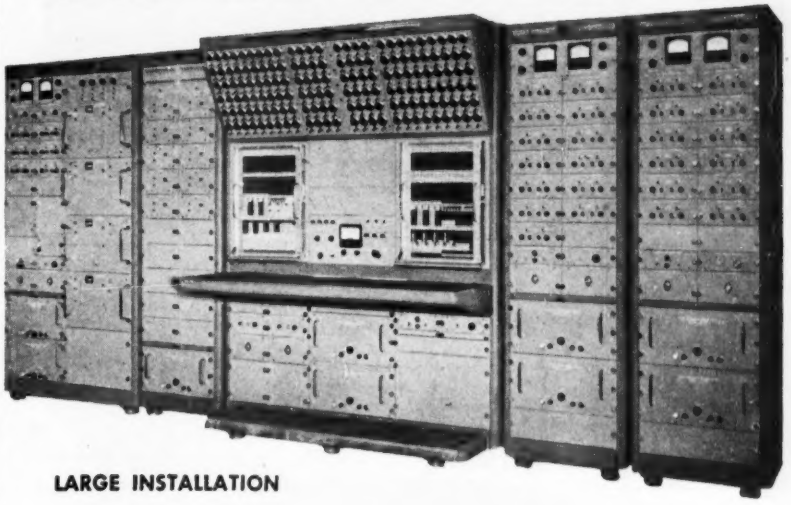


For more information circle **354** on inquiry card.

Miniature Relays

New "Class 22" telephone-type relays, hermetically-sealed, dust-tight enclosed, and open types, are espe-

MODERN Problems Demand ... MODERN SOLUTIONS

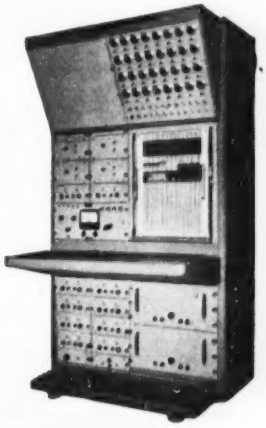


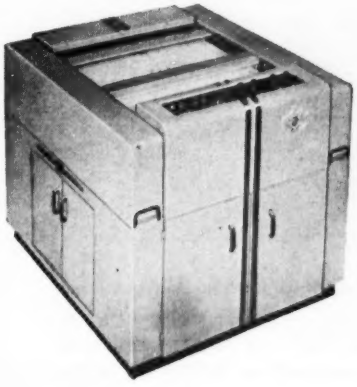
LARGE INSTALLATION

This large computer is used for the rapid solution of aero-dynamic problems. It consists of 50 operational amplifiers, 10 servo multiplying channels, 4 resolving channels, and a control console with two pre-patch bays, 156 attenuators, two voltmeters, and all necessary operational controls.

SINGLE PACKAGE COMPUTER

Our Type 16-31R Computer is a single package computer capable of solving differential equations with many simultaneous elements which are often encountered in the simulation of dynamic systems. It contains 20 operational amplifiers, 4 servo multipliers, thirty-two attenuators, all-metal removable problem board, and complete control panel.





PLOTTING EQUIPMENT

For presentation of problem solutions, the Variplotter Plotting Boards provide an accurate inked record. Typical uses include the automatic plotting of: Analog Computer output; guided missile data; engine performance characteristics; and control of manufacturing processes. With accessory equipment the range of applications can be greatly extended.

Write Dept. I

ELECTRONIC ASSOCIATES Incorporated

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LONG BRANCH • NEW JERSEY

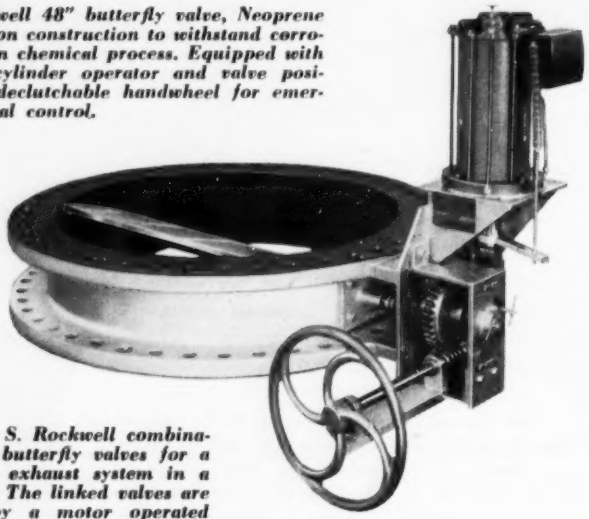
Visit our booth 329-333 Computer Avenue at the I R E National Convention Kingsbridge Armory, New York City

For more information circle **100** on inquiry card.

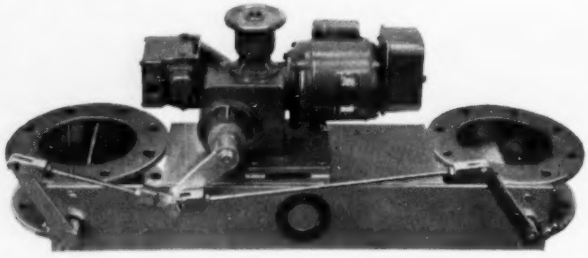
PERFORMANCE *plus*

AUTOMATIC-MANUAL
VERSATILE
Control and Shut-Off

W. S. Rockwell 48" butterfly valve, Neoprene lined cast iron construction to withstand corrosive action in chemical process. Equipped with pneumatic cylinder operator and valve positioner and declutchable handwheel for emergency manual control.



Below — W. S. Rockwell combination of two butterfly valves for a trap hopper exhaust system in a power plant. The linked valves are controlled by a motor operated gear reducer unit through limit switches so that when one valve is fully open, the other is fully closed.



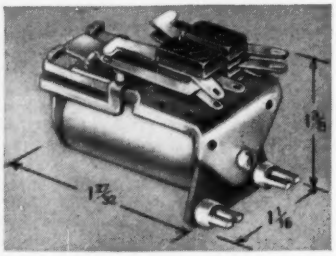
For minimum pressure drop, uniform quick control and positive shut-off—commercial, drip or air tight—W. S. Rockwell Valves are your answer. Sizes to 132"; pressures to 900 p.s.i., and higher; temperatures to 2000° F. Made of any metal or rubber lined. Write for Valve Catalog.

W. S. ROCKWELL VALVES

W. S. ROCKWELL COMPANY
2644 ELIOT ST. • FAIRFIELD, CONN.

For more information circle **101** on inquiry card.

NEW INSTRUMENTS



cially adaptable to low-wattage sensitive applications and for requirements where one relay must perform a large number of switching functions with minimum input power. Available 60-cycle a.c., any voltage to 440; d.c., any voltage to 230; great variety of contact combinations; coil resistance from 0.12 to 21,000 ohms; time delay—slow release to 125 milliseconds.—*Magnecraft Electric Co., 1442-H W. Van Buren St., Chicago 7, Ill.*

For more information circle **355** on inquiry card.

Time Delay Relays

New hermetically-sealed miniaturized time delay relays are designed to take up less space than previous models; can be supplied with 50-, 60- or 400-cps. a-c. or governed or standard d-c. motors. Lightweight aluminum 2.5-in.-diam. hermetic housing; basic length for a single switch unit 2.94 in. Three-stud or flange mounting.—*The A. W. Haydon Co., 232 N. Elm St., Waterbury, Conn.*

For more information circle **356** on inquiry card.

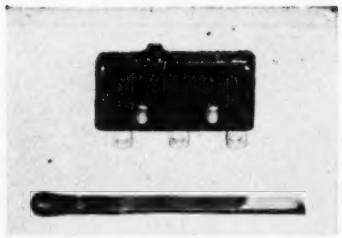
Shock-resistant Relays

New hermetically-sealed miniature relays for high shock and high vibration applications feature rotary armature with dynamically and statically balanced structure. Available in 2-, 4-, and 6-p. d-t. models in two sizes: 1⅝ and 115/16 in. in height. Temperature ranges –65 C. to 200 C. Coils 7 to 30,000 ohms, 6 to 400 volts; contact ratings to 5 amps. at 28 v.dc. or 115 v.ac. 400 cps. Vibration: up to 2000 cps. at 20 G; shock: up to 125 G electrical and 250 G mechanical. Manufactured to military specs.—*S. H. Couch Co., North Quincy 71, Mass.*

For more information circle **357** on inquiry card.

Subminiature Basic Switch

New subminiature basic switch is adaptable for use on military applications, also business machines, sensitive diaphragms and other "feather-



touch" devices. Standard actuators: toggle, push-button and leaf spring. Special housings include hermetically-sealed cases and rotary or gang assemblies. 2.5 or 5 amps. 125/250 vac., 30 vdc 2.5 amps inductive or 30 vdc 4.0 amps. resistive.—*Electro-Snap Switch & Mfg. Co.*, 4218-30 *W. Lake St., Chicago* 24, *Ill.*

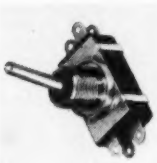
For more information circle **358** on inquiry card.

Power Switch

New "Series AE" power switch, for use as push-pull or rotary switch in such applications as record changers, is Underwriters listed; rated 1 amp. 250v., 3 amp. 125v.,a.c. or d.c.; available in s.p.s.t., s.p.d.t., or d.p.s.t. 13/16 in. diameter.—*Clarostat Mfg. Co., Inc., Dover, N. H.*

For more information circle **359** on inquiry card.

Sealed Toggle Switch



New sealed miniaturized toggle switch is a d-p.d-t. unit, miniaturized and tested for a load of 10 amp. at 250 volts; sealed in a bushing for panel mounting by means of a bonded silicone rubber diaphragm tested statically at 240 psi. and up to 150,000 operating cycles at 90 psi. Switch has in its two throw positions a positive locking force between contacts of 500 grams, resisting tendency for contacts to separate and arc under vibration or impact. Poor contacts due to corrosion of riveted connections have also been avoided since current is transferred to contacts directly by contact springs. —*Krautter-Weber Tool Co.*, 69-77 *Twelfth Ave., Newark* 3, *N. J.*

For more information circle **360** on inquiry card.

Sealed Switch Bushing

New sealed switch bushing is for toggle switches, telephone switches, circuit breakers, etc., which have to be mounted in a sealproof manner. Maximum deflection, plus and minus 25 deg. Silicone rubber diaphragm, bonded to stainless steel handle and stainless steel bushing, is tested from –40 C. to 150 C. at a maximum pressure of 90 psi. (at room temperature, 240 psi.); 150,000 cycles of operation without leakage at 90 psi. Bushing diam. 15/32 in.; 32 threads per inch; key slot for radial location.—*Krautter-Weber Tool Co.*, 69-77 *Twelfth Ave., Newark* 3, *N. J.*

For more information circle **361** on inquiry card.

Power Connectors

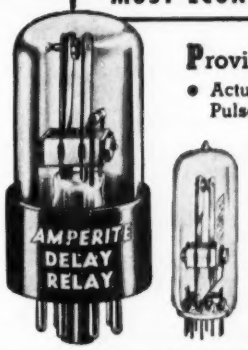
New power connectors for applications requiring current capacities of #16 AWG wire feature disengage-

MINIATURIZING YOUR EQUIPMENT?

Specify SIMPLEST, MOST COMPACT

AMPERITE THERMOSTATIC DELAY RELAYS

MOST ECONOMICAL, HERMETICALLY SEALED



STANDARD MINIATURE

Provide delays ranging from 2 to 120 seconds.

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
- Circuits: *SPST only* — normally open or normally closed.

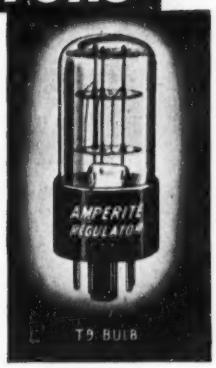
Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from —55° to +70°C. Heaters consume approximately 2 W. and may be operated continuously. The units are *most compact, rugged, explosion-proof, long-lived,* and — *inexpensive!*

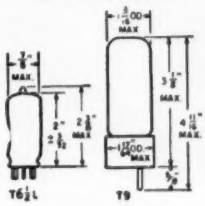
TYPES: Standard Radio Octal, and 9-Pin Miniature.

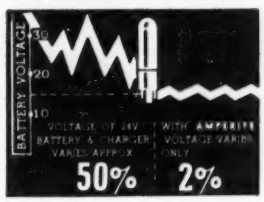
PROBLEM? Send for Bulletin No. TR-81

BALLAST-REGULATORS

- Amperite Regulators are designed to keep the current in a circuit ***automatically regulated*** at a definite value (for example, 0.5 amp).
- For currents of 60 ma. to 5 amps. *Operates on A.C., D.C., Pulsating Current.*
- Hermetically sealed, light, compact, and most inexpensive.







Maximum Wattage Dissipation: T6½L—5W. T9—10W.

Amperite Regulators are the simplest, most effective method for obtaining ***automatic regulation*** of current or voltage. ***Hermetically sealed,*** they are not affected by changes in altitude, ambient temperature (—55° to +90°C), or humidity. Rugged; no moving parts; changed as easily as a radio tube.

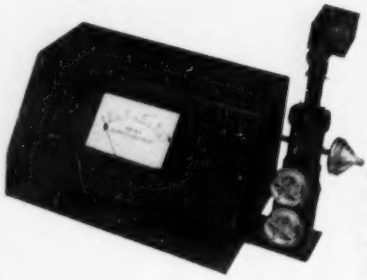
Write for 4-page Technical Bulletin No. AB-51

AMPERITE CO. Inc., 561 Broadway, New York 12, N. Y.

In Canada: Atlas Radio Corp., Ltd. 560 King St. W., Toronto 2B

For more information circle **102** on inquiry card.

The New Sinclair-Phoenix Aerosol and SMOKE PHOTOMETER



Indicating—Recording—Portable

Model JM-1000

The forward-scattering principle offers the most practical, intelligent method of accurate air pollution studies, measurements and means of control, yet has numerous other applications.

TYPICAL APPLICATIONS

- Study, Measurement and Control of Air Pollution in and Around Cities, Industrial Areas, Offices, Apartment Buildings, Plants, Mines, Hold of Ships, etc.
- Control and Research Tool for Rapid Evaluation of Filter Designs, Testing Efficiency of Fans, Air-Wash Systems and Filtering Devices, Air Conditioners, Purity of Oxygen and Other Gases.
- Medical Research for Studies, Measurements of Respiratory Accumulation of Dust and Smoke Particles.

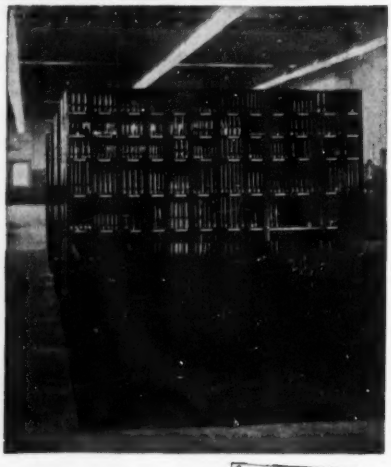
Phoenix Precision Instrument Co.

3803 N. 5th St., Philadelphia 40, Pa.

For more information circle **103** on inquiry card.

AVAILABLE NOW! from Stock

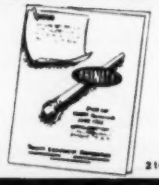
THERMOWELLS



—in a wide variety of designs, sizes and materials.

We will be glad to place your name on the list to receive copies of the monthly Trinity Thermowell Stock List.

• *Request your copy now.* •



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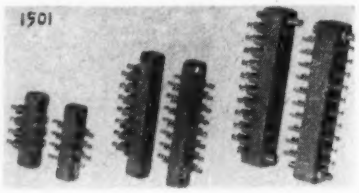
TRINITY EQUIPMENT CORPORATION

494 Westfield Ave., East Roselle Park, New Jersey

THERMOWELLS and other Specialties for the Process Industries

For more information circle **104** on inquiry card.



ment forces of 3 oz. minimum per contact and 8 oz. max. without sacrificing conductance. Telescoping barriers around each contact provide extra-long creepage paths for high-voltage applications. Turret-type socket and pin contacts (available in 7, 10, 15, 18 and 20 contacts) are silver-plated spring-temper phosphor bronze and brass respectively; come assembled in a unique floating non-rotating arrangement which insures self-alignment of each contact. Positive wiping action. Choice of three insulating materials.—*Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.*

For more information circle **362** on inquiry card.

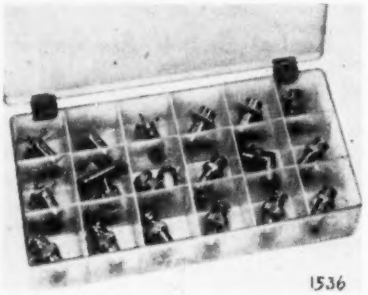
Ceramic-Metal Terminals

New high-temperature insulators and terminals of metallized ceramic, rated for brazing and service temperatures up to 1400 F. yet said to be priced competitively with lower-temperature units, are for hard-solder applications where severe thermal shock is encountered. Diameters from 7/32 in. through ½ in. and ratings from 3400 to 14,000 volts; larger sizes to specifications. Maker's service includes cooperation on design of units and related equipment in respect to alloys used, as well as performance of actual brazing of units into metal closures or other parts.—*Advanced Vacuum Products, Inc., 22 Liberty St., Stamford, Conn.*

For more information circle **363** on inquiry card.

Coaxial Connector Kits

Three new "RF Coaxial Connector Kits" are available, each with 18 connectors and a functional wiring diagram; save time and labor on experi-



1536

mental and prototype work. Kit No. 1 contains "BNC" connectors for use on small coaxial cables; No. 2 contains "UHF" connectors for use with non-constant impedance applications; No. 3 contains "N" connectors for use on microwave applications.—*Schweber Electronics, 122 Herricks Road, Mineola, L.I., N.Y.*

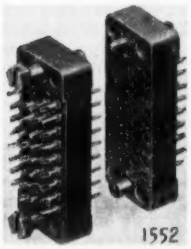
For more information circle **364** on inquiry card.

Multi-contact Connectors

New "AN-E Series" multi-contact electric connectors are designed to resist extreme environmental conditions under MIL-C-5015A (ASG). Claimed: "higher dielectric strength with greater arc resistance, water repellancy, resistivity, corrosion resistance, and higher potential test voltage and contact current ratings than have previous specifications." Shells are of single-piece construction with integral clamps; angle 90-deg. plug (illustrated) has a removable clamp.—*Cannon Electric Co., P. O. Box 75, Lincoln Sta., Los Angeles 31, Calif.*

For more information circle **365** on inquiry card.

Miniature Connectors

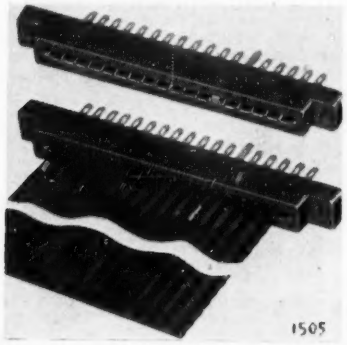


New "Continental Series 20" miniature rectangular connectors feature "Polarizing Screwlock" guide pins and guide sockets which provide (1) positive means of locking plug and receptacle against vibration or accidental disconnection; (2) mechanical means of disconnecting plug from receptacle without prying or forcing. Available in 7, 9, 11, 14, 18, 21, 26, 34, 41, 50, 75 and 104 contacts. Hoods with top- or side-opening feature are also available.—*Electronic Sales Div., Dejur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.*

For more information circle **366** on inquiry card.

Printed-circuit Connectors

New "Series PC" space-saving printed-circuit "Continental Connectors" permit direct connection to a printed circuit "plug" or "plug"-mounted subassembly. Both sides of printed circuit card can be used for wiring to external circuit with double-row contact construction: up to 30 ("PC-15"), 36 ("PC-18"), and 44



A.C. or D.C. Feedback with DIEHL

LOW INERTIA SERVOMOTORS AND INTEGRALLY-MOUNTED TACHOMETERS

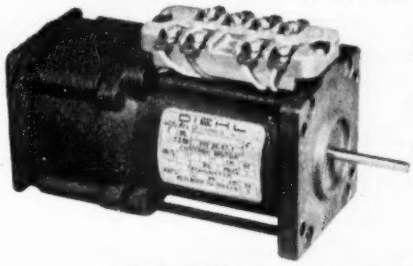
Response and stabilization of *Positioning Systems* can be improved with the Diehl Servomotor and *A.C. Tachometer*.

Analog System integration is facilitated by the use of the Diehl Servomotor with *D.C. Tachometer* combination.

Save space . . . and eliminate coupling problems and backlash . . . with these integrally combined units, motor and generator on the same shaft.

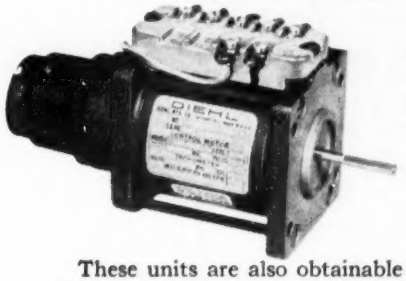
Diehl 5-watt output, 2-phase, 115/115 volt, 60 cycle, 2-pole Low Inertia Servomotors are available with a drag-cup type A.C. generator or with a permanent magnet D.C. generator mounted on the Servomotor as an integral unit, as illustrated:

MOTOR WITH A.C. TACHOMETER—NO. S.S. FPE25-67-1



Stalled torque: 5.0 oz. in.
Rotor moment of inertia: 0.18 oz. in.^{2}
Tachometer output: 6 volts/1000 R.P.M.

MOTOR WITH D.C. TACHOMETER—NO. S.S. FPE25-86-1



Stalled torque: 5.0 oz. in.
Rotor moment of inertia: 0.18 oz. in.^{2}
Tachometer output: 6.5 volts/1000 R.P.M.

These units are also obtainable for 10 watts output. Both the 5 and 10 watt units can be supplied with control windings for operation directly from the plates of vacuum tubes, or for 400 cycle operation.

Our engineering staff will gladly help you select the units best suited to your specific requirements. A request on your letterhead will bring you a copy of Technical Manual No. IN-0354 describing Diehl Servomotors and related equipment.

Other Available Components:
D.C. SERVO SETS • RESOLVERS
MINIATURE PERMANENT MAGNET D.C. MOTORS

Diehl
DIEHL MANUFACTURING COMPANY
Electrical Division of THE SINGER MANUFACTURING CO.
Finderne Plant, SOMERVILLE, N. J.
Atlanta Baltimore Boston Chicago Detroit New York Philadelphia Worcester

For more information circle **105** on inquiry card.

When your problem involves drying air to obtain more efficient, dependable instrument operation, the Industrol Dynamic Dehumidifier offers you a practical low cost solution.

Dryers are offered with manual, semi-automatic or fully automatic control. Heat regeneration of desiccant is supplied by either electricity or steam.

An Industrol Dynamic Dehumidifier used in conjunction with the Industrol Centrisorb Filter is the ideal combination to give you the clean, dry air that spells trouble-free instrument operation.

Prove to yourself why more plant operating men are specifying Industrol. A qualified engineer is available to consult with you on your dryer problems.

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SINCE 1926

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For more information circle **107** on inquiry card.

NEW INSTRUMENTS

("PC-22") contacts. New connectors are also available in single-row construction.—*Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.*

For more information circle **367** on inquiry card.

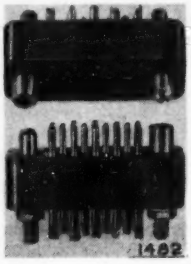
Angle Pulse Connectors

New "Guideline" angle pulse connectors for aircraft radar and microwave communications systems maintain high corona levels at altitudes up to 10 miles. New construction features conducting compound completely surrounding inner conductor, penetrating any interstices and preventing development of any air spaces between conductor and dielectric. Because of their exceptionally high corona level, new connectors will be employed principally with cable RG-88/V; but may be used with other cables and will mate with standard rubber insert type connectors; meet all applicable portions of MIL-C-3606. —*Dep't H, Airtron, Inc., Linden, N.J.*

For more information circle **368** on inquiry card.

Miniature Connectors

New "VT Series" miniature rectangular connectors are available with 7, 8, 14, 18, 20, 21, 34 and 41 contacts (also a 25-contact unit with one high-voltage contact). Polarizing guides optional; hoods available. Socket contacts are spring types which snap in and out easily without special tools; require no "C" rings: no rings to remove and replace during disassembly, and no undercutting needed to seat a "C" ring on solder-pot side. Polarizing guide socket, of beryllium copper, incorporates a 4-leaf arrangement. Any leaf can move independently of others, assuring that socket will retain its shape and that segments will not break off. Socket and pin contacts are silver-plated, with gold flash.—*Viking Electric, 1061 Ingraham St., Los Angeles 17, Calif.*

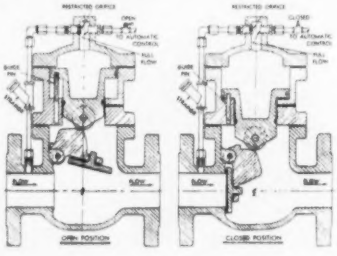


For more information circle **369** on inquiry card.

VALVES

Piston-operated Valve

New piston-operated valve closes against line flow (no line shock) and opens with line flow to permit full



flow; operates automatically or manually as a deluge valve in spray and sprinkler systems; can be remotely controlled to open or close at any desired speed. Remote control can be by solenoid valve, by compressed air, by water, or by fluid in line.—*McRae Corp.*, 621 *S. Spring St., Los Angeles* 14, *Calif.*

For more information circle **370** on inquiry card.

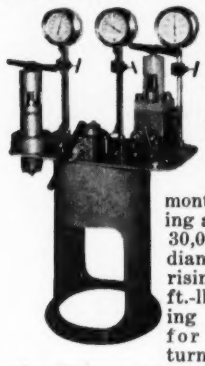
Solenoid Valves

New line of cast iron and cast steel solenoid valves is available in sizes from ½ in. to 2 in.; pressures to 1000 psi. at 200 F., 500 psi. at 450 F. New features include stick-free internal design, stainless steel hooded pilot seat screw and Teflon disks inert to all media except hot fluorine.—*Dep't* 199, *Atkomatic Valve Co.*, 545 *Abbott St., Indianapolis* 15, *Ind.*

For more information circle **371** on inquiry card.

High-pressure Valves

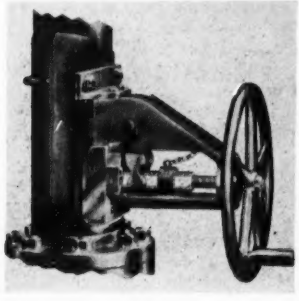
New standardized high-pressure valves for plant-size operations are said to have been "heretofore unavailable; result of . . . experience with similar equipment in laboratory sizes." Illustration shows three valves which were pressurized for one month without showing any drop. (Left) 30,000 psi., ⅝-in. diam. port and non-rising stem; open 25 ft.-lb. torque; closing 8 ft.-lb. torque for about half a turn. (Center) 6000 psi., ⅝-in. port and rising stem; 25 ft.-lb. torque to open. (Right) 15,000 psi.; 13/16-in. port; operating torque once valve is open is less than 5 ft.-lb.—*Autoclave Engineers, Inc., P. O. Box* 1027, *Erie, Penna.*



For more information circle **372** on inquiry card.

Emergency Valve Handwheel

New "Type Y Continuously Connected Side Handwheel," for emergency manual control in case of dia-



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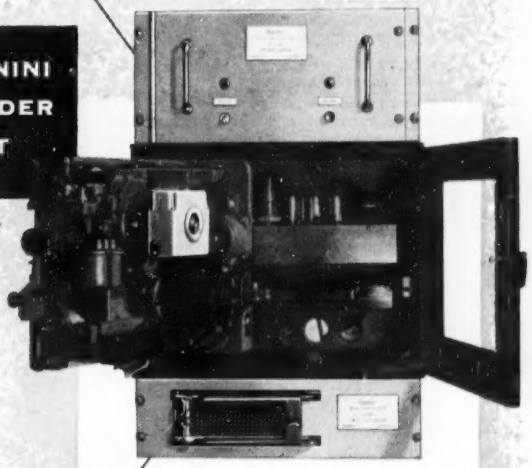

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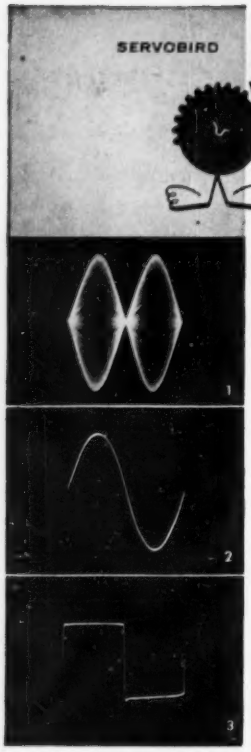
For more information circle **108** on inquiry card.



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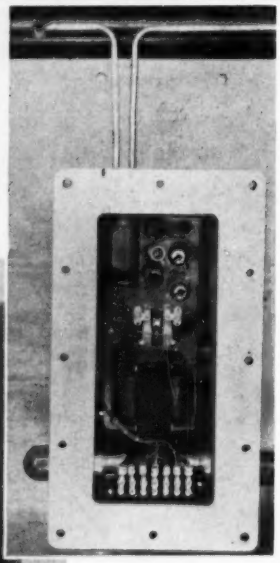
For more information circle **109** on inquiry card.

COLOR ALARM
for Continuous Process Analysis



Now, any deviation in color or turbidity of flowing liquid can be instantly and automatically determined. "Color Alarm" provides a visual and/or audio signal whenever color of flowing liquid deviates from preset limit. "Color Alarm" can be attached anywhere on flow line and set to actuate cut-off valve. Ends delay and expense of laboratory testing.

SHELL Development Design

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Analytical instruments for continuous processes

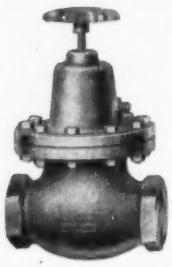
For more information circle **110** on inquiry card.

NEW INSTRUMENTS

phragm or operating medium failure, is designed for use with all of maker's diaphragm control valves. Handwheel screw is made of non-galling 18-8 stainless steel with a high-tensile aluminum-bronze nut for transmitting power through a cast-steel fork to valve stem. Stops allow travel to be set for any portion of complete valve stroke.—*Black, Sivalls & Bryson, Inc., 7500 E. 12th St., Kansas City 3, Mo.*

For more information circle **373** on inquiry card.

Constant-back-pressure Control Valves

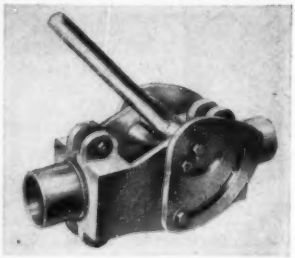


New "Type KD Automatic Back Pressure Control Valves" automatically maintain a constant back pressure on inlet side, regardless of variation of pressure at valve outlet, and regardless of changes in demand or flow. High capacity results from multiple-ported seat arrangement. Sizes range from ½ in. to 2 in.; screwed ends; with or without hand-wheel for manual pressure adjustment.—*A. W. Cash Valve Mfg. Corp., Decatur 60, Ill.*

For more information circle **374** on inquiry card.

Pinch-type Valve

New "Type K" manually-operated quick-opening pinch-type rubber valve for handling slurries with grain

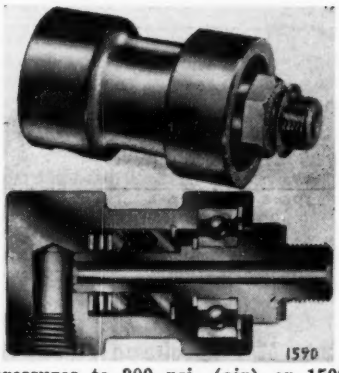


sizes up to ⅛ in., and corrosive chemicals, is available in sizes ¼ in. through 12 in. in pure gum rubber, neoprene, Buna, Butyl, and odorless and tasteless neoprene. Temperature limit 180 F., pressure limit 100 psig. Valve is for on-off service; has snap action at closing point; bubble tight closure. Only rubber in contact with fluid.—*Robert K. Little, 1623 Elaine St., Philadelphia 19, Pa.*

For more information circle **375** on inquiry card.

Revolving Joint

New "Type NV" light-running revolving joint with ¼-in. I.D. for pneumatic or hydraulic service, features (1) new one-piece bronze casing, (2) spring-loaded V-ring seals, (3) hardened and ground steel shaft, (4) permanently-lubricated sealed ball bearing. All parts readily removable and replaceable. New joint is suitable for use at temperatures up to 180 F. and



pressures to 300 psi. (air) or 1500 psi. (hydraulic). Maximum speed 2500 rpm. for normal applications; lower speeds for high pressures and temperatures.—*Dep't. J-41, Barco Mfg. Co., 500 Hough St., Barrington, Ill.*

For more information circle **376** on inquiry card.

MISCELLANEOUS

Moisture Meter

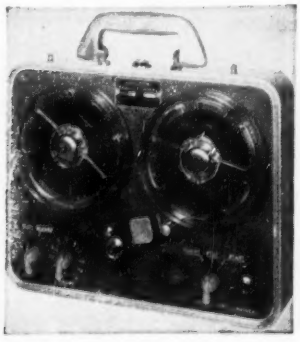
New "Olivo Moisture Meter" measures surface moisture in powdered, granulated or fibrous material in less than two minutes. Announcement

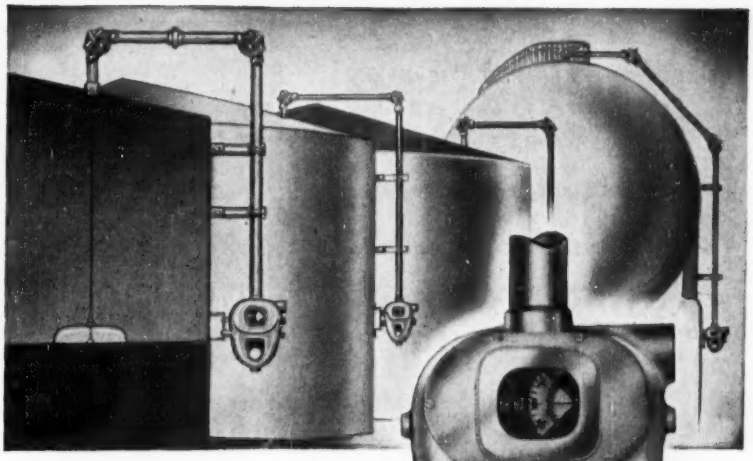
states: "Using other laboratory methods, the same moisture tests would take as long as four hours." When properly calibrated, it is accurate to 2 percent of surface moisture.—Available in U. S. through *Heyl & Patterson, 55 Fort Pitt Blvd., Pittsburgh 22, Pa.*

For more information circle **377** on inquiry card.

Portable Tape Recorder

New "Flyweight Magnemite" is a battery-operated 8-lb. weather-tight magnetic-tape recorder designed for field use. Among features: fly-ball governor-controlled electric motor;





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For more information circle **111** on inquiry card.

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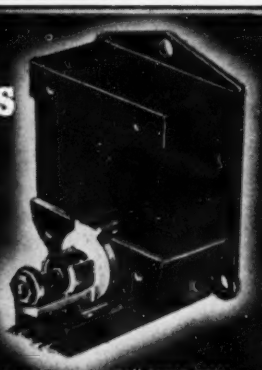
For more information circle **112** on inquiry card.

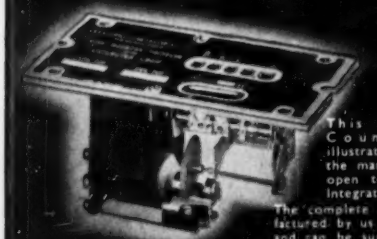
LOW-INERTIA INTEGRATING MOTORS



Low-Inertia Integrating Motors are permanent magnet D.C. motors in which practically all factors likely to affect the linearity of the voltage/speed curve have been eliminated, e.g., friction, iron losses, brush-contact voltage drop. The resulting accuracy is such that they can be used to integrate minute voltages on a time basis. By using a suitable transducer, temperature difference, or any other quantity, can be converted into a voltage signal, which then enables the motor to integrate this figure over time.

Low-Inertia Integrating Motors can be used in instrument-type servo-mechanisms for driving light loads, for operating mechanical counters performing integration, or as small power generators. The sensitivity of the motor is such that it will operate directly off a photo-cell or thermo-couple.

Available in 4 types: nominal voltages 1.5 V.; 6 V.; 12 V.; 24 V. D.C.



This Mechanical Counter Unit illustrates just one of the many applications open to Low-Inertia Integrating Motors.

The complete unit is manufactured by us in four types and can be supplied to suit D.C. voltages of 1.5, 6, 12 or 24 volts.

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For more information circle **113** on inquiry card.

NEW INSTRUMENTS

built-in indicator shows when motor batteries should be replaced; non-microphonic subminiature tubes; ultrasonic bias for maximum fidelity at reduced tape speeds; electrical rewind of full reel in less than two minutes. Available in three different models providing playing time of up to four hours on a standard 600-ft. roll of ¼-in. tape on a 5-in. reel.—*Magnemite Div., Amplifier Corp. of America, 398 Broadway, New York 13, N. Y.*

For more information circle **378** on inquiry card.

Magnetic-tape Reel

New 8-in. all-metal 1200-ft. reel uses standard NARTB hub to eliminate tape stretch, breakage, and pitch changes as tape approaches end of reel; can be used on any machine which takes NARTB hub. (Until now, critical recordist had to use a 10½-in. reel, regardless of length of tape, to avoid extreme tension on tape near end of small reel.)—*Ampex Corp., 934 Charter St., Redwood City, Calif.*

For more information circle **379** on inquiry card.

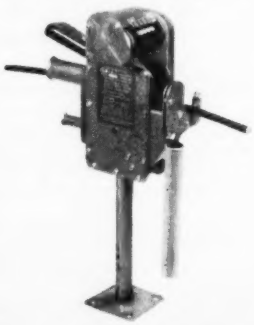
Shaker Power Supply

New "68" electronic power supply is for use with several of maker's vibration-test shakers. When used with "6CT" shaker, it provides a force output of 50 lbs.; with "A88" 100 lbs. and with "44A" 200 lbs. Power consumption 20 amps. on 110 v.ac. It permits users to start out with one basic power supply and, as force requirements grow, add shaker units.—*Calidyne Co., Winchester, Mass.*

For more information circle **380** on inquiry card.

Wire and Cordage Meter

New "No. 600" lineal measuring device for wire, cordage, TV ribbon, etc., has interchangeable guide tubes



for range from Nylon fishing leader to 1-in. diameter flexible electric cable or cordage. Veeder-Root counter registers feet and inches to 9,999 feet. Wax scraper cleans meter wheel to maintain accuracy. ★Also available is a cutter (illustrated) and complete line of reeling equipment.—*Olympic Instrument Labs., Dept. CB, Cove, Wash.*

For more information circle **381** on inquiry card.

Standard Comparison Slides for Diamond Grade, Purity

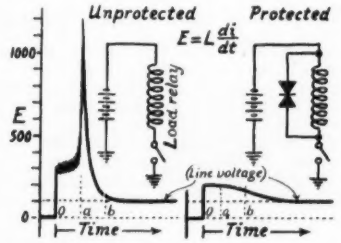
New set of Master Comparison Slides has been developed for use in microscopic inspection of diamond abrasives: permit examination of diamond particles in grades ranging from 1 micron to 100 mesh through comparison of diamond powder or compound with diamond on master slide. Determination of impurities may also be made microscopically with aid of a polarizing attachment. A printed table, provided with box of gages, shows recommended NBS grade numbers, particle size range of each grade, and a rough comparison with old powder numbering system.—*Abrasives Div., Elgin National Watch Co., Elgin, Illinois.*

For more information circle **382** on inquiry card.

Contact Protector

New Contact Protector is a unique back-to-back arrangement of selenium rectifier cells for eliminating destruc-

tive effects of arcing at contact points; provides a low-cost solution of costly problem of contact erosion faced by companies employing relays

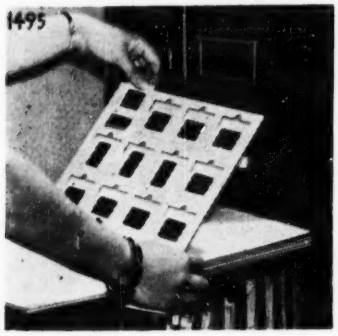


and switches making billions of contacts a year. Peak-voltage and time characteristics of 24 tubular models make them applicable to all equipment drawing up to 600 ma. and up to 150 volts, a.c. or d.c. (Larger current applications require stacks.)—*Selenium-Intelin Dep't, Federal Telephone and Radio Company, 100 Kingsland Rd., Clifton, N. J.*

For more information circle **383** on inquiry card.

Lantern-slide Mounts

New "Vue-File" mounts make it possible to have an album for slides; to visually select desired slide: twelve



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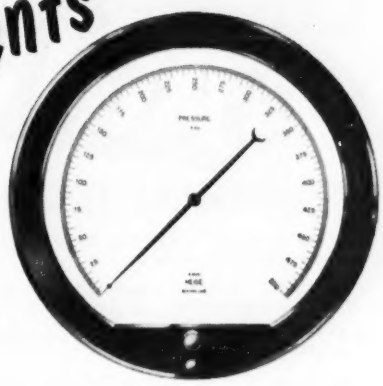
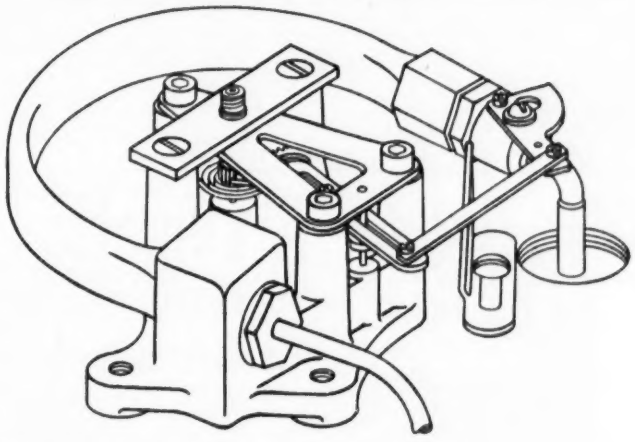


HEISE GAUGES



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For more information circle **114** on inquiry card.

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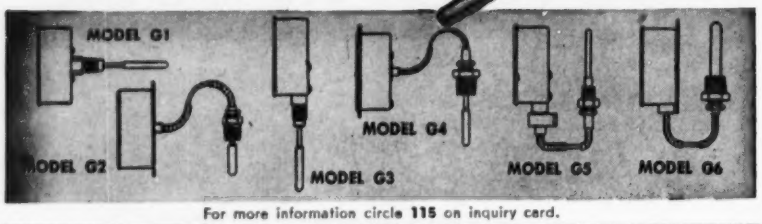

For more information circle 115 on inquiry card.

NEW! Atkomatic SOLENOID
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NEW INSTRUMENTS

slides seen at a glance; and to end laborious coding and slide description. Among features: Normal indoor light reflects through slide; finger slots for quick removal; mounts fit standard notebook; slides quickly indexed; filing system easily expanded; information can be written on film mounts.—*Burke & James, Inc., 321 S. Wabash, Chicago 4, Illinois.*

For more information circle **384** on inquiry card.

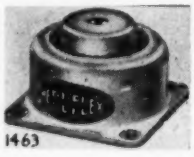
Multiple-surface Filters

New large-capacity filters with filter areas up to 720 sq. ft. and cake space capacity up to 35 cu. ft. feature filter medium of high-temperature-resistant porous stainless steel. Container can be either carbon steel or stainless steel. Compact design permits steam jacketing, high-pressure construction, sanitary construction and ease of cleaning. Illustrated is a unit with 30 sq. ft. of filter area housed in a stainless steel container 12 in. diam. by 20 in. long.—*Micro Metallic Corp., Glen Cove, N. Y.*

For more information circle **385** on inquiry card.

Vibration and Shock Mount

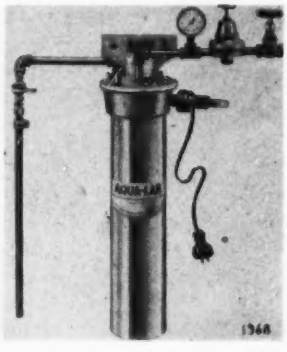
New "Model 1202" cup-type all-metal mount for protecting instruments, etc., in mobile, shipboard and industrial applications, employs a resilient cushioning material of metal wire ("Met-L-Flex") which will not pack down or wear out. Feature of new mount is top and bottom "Met-L-Flex" buffers providing gradual increase in stiffness, plus high damping for positive, negative and radial motion and shock.—*Robinson Aviation, Inc., Industrial Div., Teterboro, N. J.*



For more information circle **386** on inquiry card.

Water Demineralizer

New "Aqua-Lab" water demineralizer is said to convert tap water to high purity water "without the usual time lag between usage"; has steel shell made to withstand pressure to 100 psi., thereby permitting



connection directly to water supply even when unit's outlet valve is turned off. Thus, unit retains a reserve of demineralized water, ready for use at turn of valve. Unit operates on ion-exchange principle; utilizes a replaceable cartridge; has a mineral detector (known as "Aqualite") which eliminates guesswork by automatically switching off and warning that cartridge needs replacement.—*Automatic Steam Products Corp.*, 140 *West 31st St., New York 1, N. Y.*

For more information circle **387** on inquiry card.

Video Generator

New "Model 650C White Dot Universal Video Generator" incorporates a feature to provide accurate registration adjustment of three color guns in tube of new color TV receivers. Manufacturer announces it as "the only equipment available to quickly and accurately fill TV color register adjustment requirement."—*The Hickok Electrical Instrument Co., 10528 Dupont Ave., Cleveland 8, Ohio.*

For more information circle **388** on inquiry card.

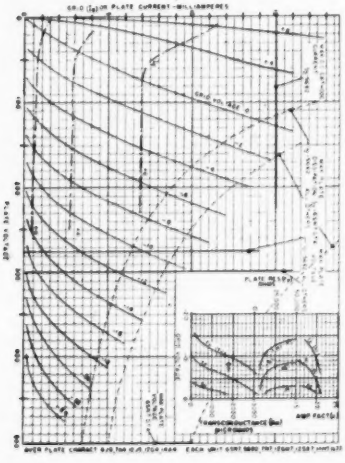
Film-pickup Vidicon

New "6326" camera tube of vidicon type is intended primarily for use in TV cameras for motion-picture film, transparencies, and opaques. Sensitivity permits televising motion-picture film with ⅓ to ½ of light requirements of iconoscope; transparencies and opaques, 1/20 of that needed for film pickup. Moreover, photoconductive layer has a spectral-response characteristic approaching that of human eye.—*Tube Dep't, Radio Corporation of America, Harrison, N. J.*

For more information circle **389** on inquiry card.

VT Characteristic Curves

New large-size (8½x11 in.) vacuum-tube characteristic curves make vacuum-tube circuit design easier and more reliable. They show plate characteristics, positive-grid characteristics, μ, g_M and r_p; reverse side of each sheet gives tabulated electrical and mechanical data and ratings for the tube and for electrically-equivalent types, showing similarities, differences, and special features. After use, sheet can be torn off pad and filed for future reference. Pads of 20 sheets are



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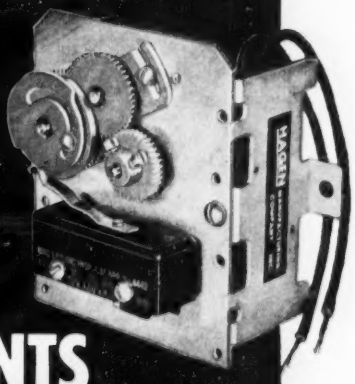

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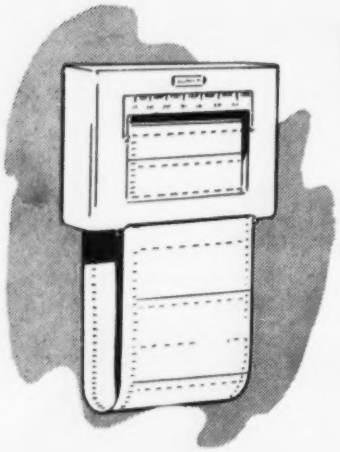

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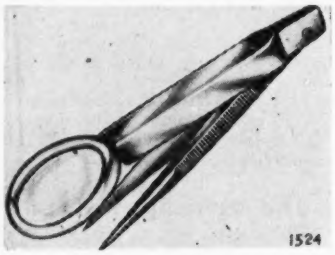
available immediately for tube types 12AU7, 12AT7, 12AX7, 6SN7, 6SL7, 6L6 pentode, 6L6 triode, 5965, and their single-unit, industrial, aircraft, rugged, and computer equivalents.—*Dep't 19, Technical Publishing House, 15 B Everett St., Cambridge 38, Mass.*

For more information circle **390** on inquiry card.

Combination Tweezers and 4-power Magnifying Glass

New "4X Miracle Tweezers" is 3.5 in. long; consists of tweezers with serrations on inside tips and on sides, to which is attached a 4X magnifier



1 in. in diameter, held in position (always directly over tweezer points) by means of a channel arm which also serves as a housing for tweezers when instrument is folded up.—*Hilco Engineering Co., Genoa City, Wis.*

For more information circle **391** on inquiry card.

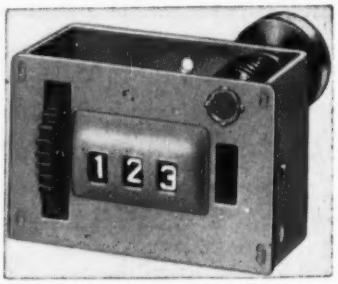
Astronomical Photometer

New type of photoelectric photometer, for direct measurement of star magnitudes, measures brightness and color of stars to accuracy of one part in a thousand; is mounted directly on telescope's plate holder and employs the same adjustments as those used for photographic plates.—*L. C. Eichner Instruments, 19 Sebago St., Clifton, N. J.*

For more information circle **392** on inquiry card.

Tape-recorder Indicator

New counter assembly indicates position of messages on tape recording machines. Before first recording



is started, indicator is reset to zero by turning knob. When recording of each message is started, number shown on indicator is written into a message index. Then, to select a particular recording for transcription, tape is run through until its index number appears on indicator.—*Production Instrument Co., 702 W. Jackson Blvd., Chicago 6, Ill.*

For more information circle **393** on inquiry card.

Soldering Guns

New models of maker's soldering guns have been "completely restyled and improved," feature five-second

heating; tip fastening arrangement which eliminates contact resistance and oxidation; pistol-grip now centered under housing for better balance; all models equipped with dual spotlights. Two new industrial models: single-heat 250-watt; dual-heat 200-275-watt.—*Weller Electric Corp., 808 Packer St., Easton, Pa.*

For more information circle **394** on inquiry card.

Electric-controls Template

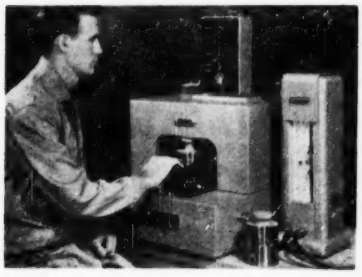
New "No. 312 Electric Controls Template," incorporating standard symbols recommended by Joint Industrial Conference in March 1953,

is made of 0.030-in. matte finish mathematical quality plastic, with printing on matte surface to minimize wear. All cut-outs are machine-milled, grouped for ease in drawing combinations of symbols most frequently appearing in sequence.—*Rapidesign Inc., Box 592, Glendale, Calif.*

For more information circle **395** on inquiry card.

Automatic Inspector for Ten Piston Dimensions

New "Multichek" automatic gage for simultaneous inspection of ten dimensions on 400 to 800 automobile pistons per hour uses colored lights to



indicate oversize, undersize, or within tolerance. When all of dimensions are within tolerance, master light remains white and nine signal lights black out.—*The Sheffield Corp., Dayton 1, Ohio.*

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Chapter IX

PNEUMATIC CONTROLLERS

In the concluding chapters, it is proposed to clarify and give point to the general theoretical discussion of the previous chapters, by describing some widely-used commercially-available control systems, and by giving some guidance for their use. Typical pneumatic and hydraulic controllers of American and British make will be presented.

Askania Regulator Co.

"Jet-Pipe Regulator"

Key element of this regulator is the Jet Pipe Relay (Fig. 9-1), which is functionally similar to a four-way valve. A pivoted stainless-steel tube is free to move, nearly frictionlessly, through a small horizontal angle. A fluid (oil or compressed air) is discharged at high velocity from the jet-pipe tip, and impinges on a plate containing two adjacent orifices, connected to opposite ends of a double-acting cylinder.

When the jet pipe is centered between the two orifices, the pressures recovered are equal in both orifices and at opposite ends of the cylinder; and the piston is stationary. If the jet pipe is deflected toward one of the orifices and away from the other, by the motion of a diaphragm or other measuring device (see Fig. 9-2), a pressure difference is set up at opposite ends of the cylinder and the piston moves to effect control. The pressure difference set up at the cylinder is a direct function of jet-pipe displacement. Thus, piston speed is a direct function of the amount of error. This is "proportional-speed floating control," which is a type of integral control action.

By the addition of mechanical or electrical feedback devices, this basic system can include the characteristics of proportional-position and proportional-plus-integral control. In Fig. 9-2, mechanical arrangements are shown for obtaining proportional and integral control actions. The left-hand diagram shows how a signal representing valve position is fed back in opposition to the error signal; in the right-hand diagram the direct feedback link between valve position and jet pipe is replaced by what amounts to a positive-displacement meter: a by-passed piston in series with the controlling piston.

It must not be assumed that all jet-pipe relays require considerable force (say nearly one ounce) to overcome frictions for accurate positioning. That friction has been minimized in some models is evident from the fact that one pneumatic model brought out about 1929 for furnace temperature control had a radiation-pyrometer primary element: the jet pipe was positioned by a permanent-magnet moving-coil mechanism. A modern version utilizes this same principle.

Bailey Meter Co.

The Bailey "Mini-Line" pneumatic control system is shown in Fig. 9-3 as applied to pressure control. It comprises a pressure transmitter, a "Mini-Line" relay, a hand-automatic selector, and a power unit. The transmitter establishes a pneumatic signal proportional to the measured variable. This signal is applied to a remote indicator, a remote recorder, and the "Mini-Line" relay.

This relay (Fig. 9-4) is used to generate proportional, derivative, integral and floating control actions as required. It also provides for remote desired-value adjustment from a manually-operated relay on the selector valve. This ratio relay may be calibrated for air pressure signal ranges of 3-27, 3-15, and 5-25 psig. It may be set either for proportional position action or for proportional plus integral action by means of a selector switch.

The selector valve provides all necessary indications and control knobs for automatic or hand operation of the system. The standard selector includes four indications of air pressures pertaining to the control-system operation, a transfer switch for rapid change to either automatic or hand control, a desired-value or bias control adjustment

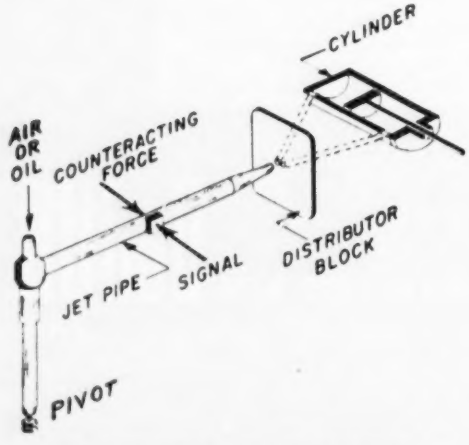


Fig. 9-1. Principle of the Askania jet pipe relay.

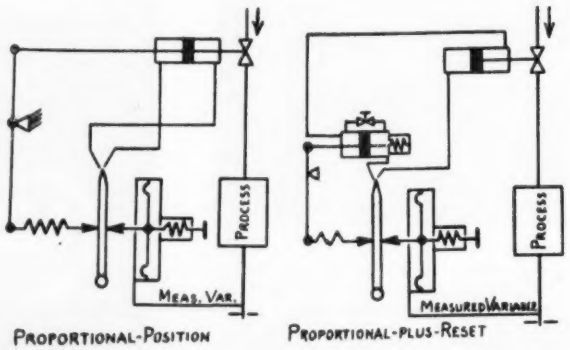


Fig. 9-2. Methods for obtaining proportional and integral control actions.

depending upon system requirements, and a hand control knob for remote manual control. Automatic-manual transfer is made without "bumping" the controlled process.

The Bristol Co.

Principal feature of the Bristol pneumatic controllers is the "free vane" first-stage amplifier. A second noteworthy feature is the unusual manner of generating integral action. Proportional action is generated as shown in Fig. 9-5. Immediately the leading edge of the vane enters the space between the two nozzles, the nozzle pressure is increased. Subsequent movements of the vane give proportional increases in nozzle pressure, just as in the flapper-and-nozzle system. The two nozzles are opposed, so that the vane suffers no reaction.

Wide-band proportional action is obtained as shown in Fig. 9-5. The band width is adjusted by altering the position of spigot s in slot s^1. The action is reversed by reversing the link carrying slot s^1 and moving the vane, so that the opposite leading edge is operative.

The desired value is set by rotating the double nozzle system as indicated in the figures.

Integral action is generated as follows: The output pressure of the controller is applied to the outside of bellows b. If the integral action restrictor is shut, changes in output pressure are simply transmitted to the feedback bellows, to give wide-band proportional action. But if the restrictor is open, air will leak to atmosphere and the pressure in the two bellows will change at a rate proportional to the time constant of restrictor plus bellows. Hence the consequent rate of movement of the proportional bellows will add integral action to the proportional action.

Derivative action is given by the restrictor between controller output pressure and the lower bellows.

The interaction factor for this design is $[1 + (r/s)]$ and the most powerful derivative action is obtained when the nominal derivative action time (r) is equal to the nominal integral action time (s); the interaction factor then is 2.

Note that when $r = s$ (and $R = \frac{1}{4}S$) the phase gain in this controller has the high value of 55 degrees when $s = \frac{1}{2}$ operating period.

*The letters r and s are used throughout this chapter for the derivative and integral times corresponding to the *settings* on the respective restrictor scales; i.e. r and s are the nominal action times.

Fischer & Porter Co.

An exception—the use of an outside-view photograph (Fig. 9-6)—is here made to show the Fischer & Porter Co. "P-4 Pneumatrol" because the Lucite-case model reveals some components of one of the various "stack" designs of

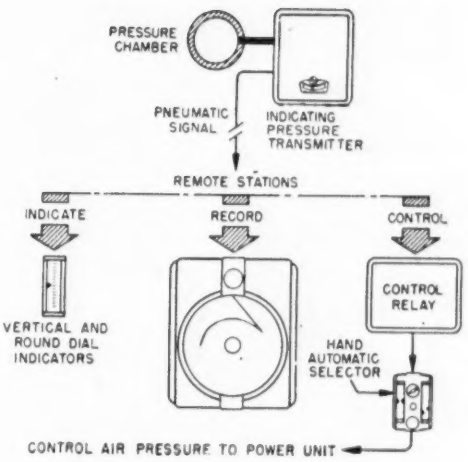


Fig. 9-3. Bailey "Mini-Line" control system.

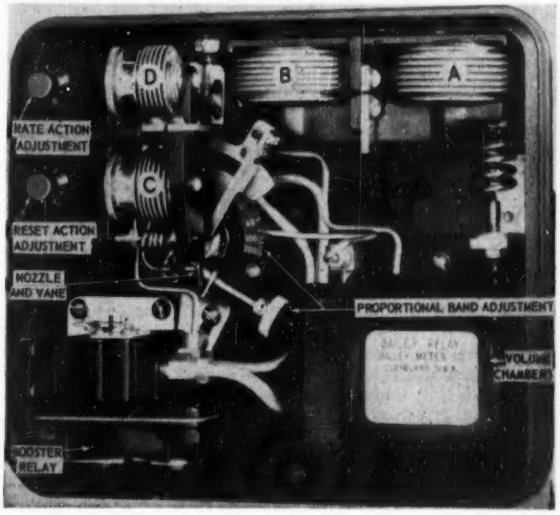


Fig. 9-4. Control unit for proportional, rate, reset and floating control actions.

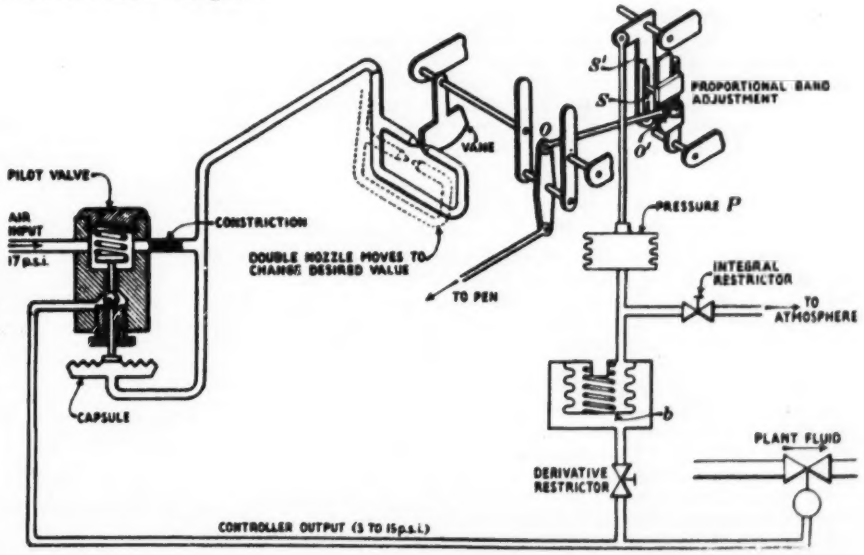


Fig. 9-5. Bristol "free-vane" controller for proportional, integral, and derivative control actions.

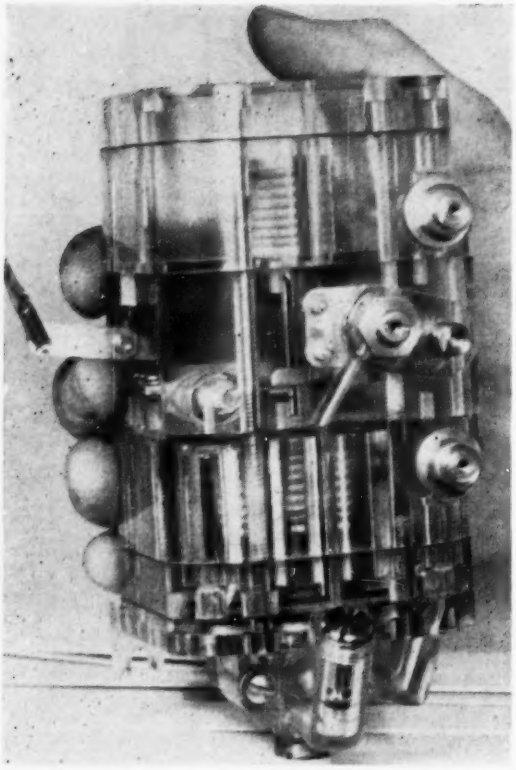


Fig. 9-6. Fischer & Porter "P-4 Pneumatrol" stack-type controller.

"blind" (non-indicating) controllers brought out by several American instrument makers.

"Blind" controllers appeared a few years ago in large American chemical and oil companies where central control rooms are hundreds of feet away from the processing units. In order to minimize distance-velocity lags, each controller was installed close to the point of measurement and to the controlled valve, damper, or other final element. This did away with the most serious dead times.

In the unit shown in Fig. 9-6, the "stack" design makes it possible to obtain an increasing complexity of control actions—in six stages from two-position to wide-band proportional with integral and derivative—by adding standardized parts.

An unusual feature of the unit shown in Fig. 9-6 is that it is a motion-input controller—as are most "instrument" controllers—rather than a force-input controller as are most "blind" controllers. This unit, however, is designed both for "case" mounting and for "field" (point-of-measurement) mounting. Note the plug-in air ports.

Foxboro Co.

1. "*Model* 40" *with* "*Hyper-Reset*"

Distinctive features of this controller are: (1) the mechanism for altering the proportional band, (2) the Bourdon tubes for integral and derivative restrictors, and (3) the third bellows inside the "feedback action" bellows to give added stability in the presence of high-frequency disturbances.

The proportional band adjustment is made by rotating the entire flapper-nozzle system (Fig. 9-7). When PC is vertical, movements of L will affect the flapper position but movement of L′ will have no effect. In this position the controller would have effectively two-position action.

By rotating the flapper-nozzle system from this position through 90 degrees, the effect of feedback (movement of L′) will be gradually increased, i.e., the proportional band

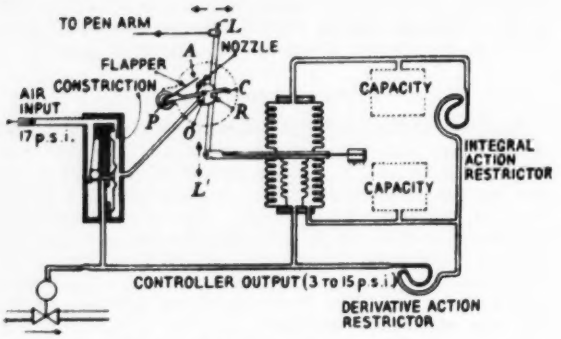


Fig. 9-7. Foxboro "Model 40" controller.

width will increase. There will be no effect on the desired value setting. The usual range of band-width supplied is 0.5 to 200 percent.

The integral and derivative action restrictors consist of Bourdon tubes whose cross-section, and hence resistance to air flow, is varied by adjusting the curvature of the tubes.

A unique feature is the small bellows fitted inside the "feedback" action bellows. Without this extra bellows, the controller design would be basically the same in principle as that which was analyzed in detail in the preceding chapter. Its purpose is to give added stability to the controller for high-frequency (short-period) disturbances. This it achieves by reducing the over-all gain of the controller at short periods, with some sacrifice of phase advance at normal periods.

The interaction factor for this type of controller is more complex than for those previously described, i.e. $[1 + (5r/2s)]/[1 + (r/2s)]$. Hence, for the ratio $s = 2r$ recommended by the maker, the factor is 1.8.

The introduction of provision for increased stability in face of high-frequency disturbances reduces the phase advance obtainable—which for the recommended value of $r/s = \frac{1}{2}$, is about 15 degrees when the integral action time (s) set on the dial is about ½ (operating period).

2. "*Model* 58 *Consotrol*"

The principle of pneumatic transmission has made it possible to build pneumatic controllers of the force-balance type,

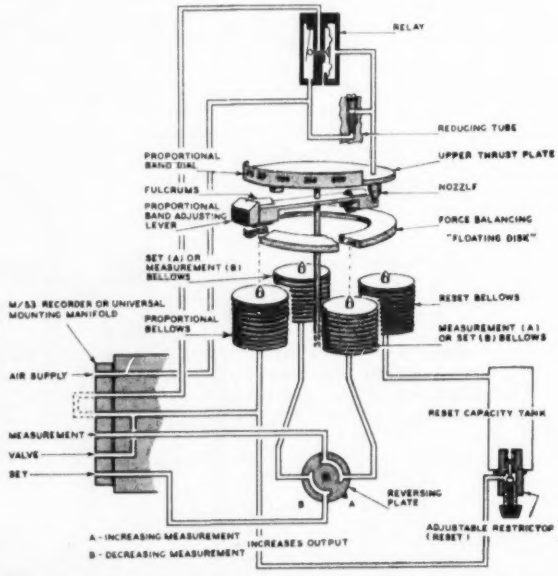


Fig. 9-8. Foxboro "Model 58 Consotrol" force-balance-type controller.

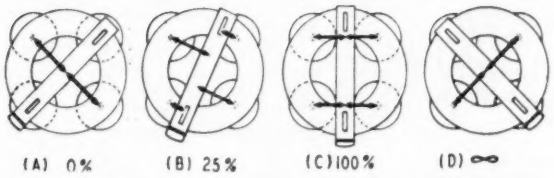


Fig. 9-9. Proportional-band adjustment on the "Model 58" floating disk.

sufficiently compact for graphic panel use. Such an instrument is the "Model 58" controller. Key element in this instrument is a unique force-balance mechanism. (Figs. 9-8 and 9-9) comprising four pressure-responsive metallic bellows positioning a free-floating disk about a fulcrum which is adjustable to produce any proportional band setting from zero to 500 percent.

The floating disk acts as the force-balance detector and as the flapper of a conventional flapper-nozzle system, enabling relay output pressure to vary in response to changes in pressure in any of the four bellows.

Each of these bellows exerts an upward force on the disk. The net effect of all forces acting simultaneously establishes the horizontal position of the disk, its nearness to the nozzle and hence the output pressure.

In operation, any change in pressure in the measurement (or set) bellows slightly raises or lowers that side of the floating disk, causes a change in nozzle pressure which operates the relay to increase or decrease the output pressure. This pressure, acting on the proportional bellows, changes enough to restore the balance. Output pressure change is thus proportional to measurement (or set) pressure change.

If there is a sustained differential between set and measurement, a sustained difference between proportional and reset bellows pressures will result. But air will flow from one to the other, causing the disk to throttle the relay and change output pressure continuously to maintain this difference. This is integral control action.

The restriction between proportional and integral bellows is adjustable and hence integral-action rate is proportional to both the amount of restriction and to the deviation of measurement from desired-value or set point.

Hagan Corporation

1. *Pneumatic Signal Transmitter*

Designed especially for use with the Hagan ring-balance flowmeter, the pneumatic signal transmitter (Fig. 9-10) is a position-balance nozzle-baffle proportional-action control unit whose output can be used to operate a diaphragm control valve or a remote indicator. Available maximum signal pressure ranges are 15, 30, and 60 psi. Proportional band is adjustable from 10 to 300 percent. The operation of the unit is evident from Fig. 9-10. Motion of the baffle causes change in pressure above the metallic diaphragm, which operates the relay valve to change the pressure in

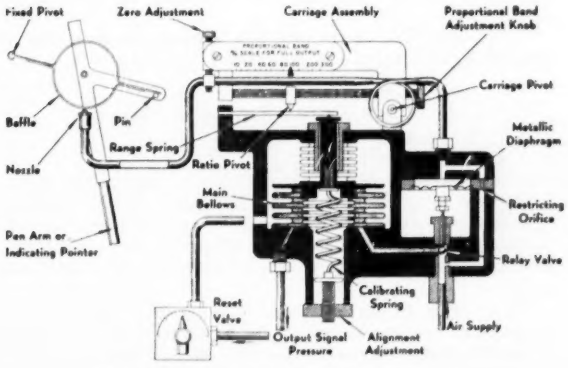


Fig. 9-10. Hagan pneumatic signal transmitter.

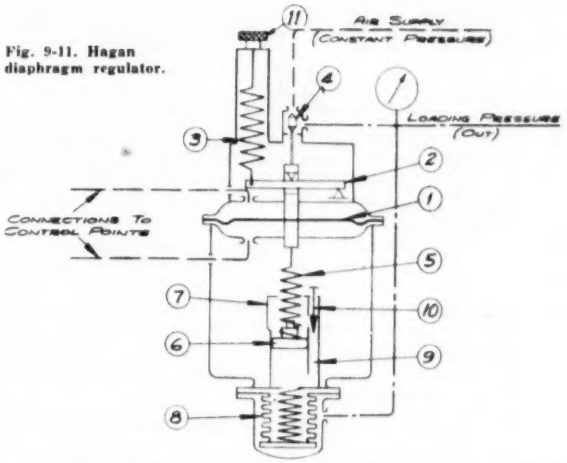


Fig. 9-11. Hagan diaphragm regulator.

the main bellows. Pressure in the main bellows causes a vertical force that acts through the range spring to move the entire carriage assembly and cause it to pivot around the carriage pivot. This repositions the nozzle to give proportional action.

When the ratio pivot is at the extreme right, the feedback proportional-action motion is the greatest, the nozzle is repositioned the most, the controller has least sensitivity, and the proportional band is maximum (300 percent).

For controlling service, the transmitter can be supplied with integral action (as shown), remote adjustable set point, or derivative action.

2. *Diaphragm Regulator*

For low-pressure or low-pressure-differential controlling service (inches water to about 3 psi.), the diaphragm regulator (Fig. 9-11) utilizes a diaphragm (1) and pivoted balance beam (2). Motion of the balance beam controls the escapement valve (4), which determines the output air signal. Proportional control action is obtained by a feedback bellows (8), which repositions the diaphragm and escapement valve. The repositioning motion operates through piston (6) in oil-filled cylinder (7) to give damped integral action. The amount of damping is controlled by valve (10) to suit the lag of the system under control.

3. *Ratio Totalizer*

Although called "ratio totalizer," this unit is a general-purpose control unit that gives not only proportional, integral and derivative actions, but also addition, subtraction, multiplication, and division actions. Hence it is both a control and a computer element. The input to the ratio totalizer is one or more signals from other signal transmitters—that is, it is a control element between pickup transmitter and final control element.

The ratio totalizer (Fig. 9-12) is a pure force-balance unit in which the pilot valve controlling the output air pressure is positioned by the action of four nonmetallic

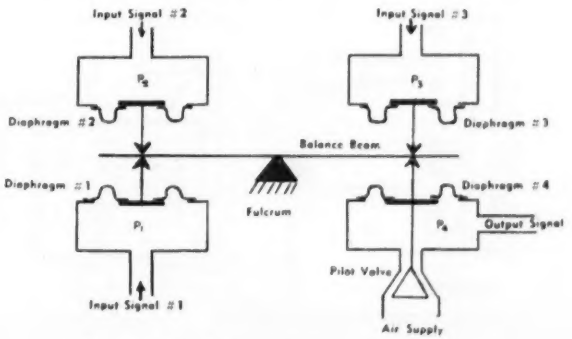


Fig. 9-12. Force-balance principle of ratio totalizer.

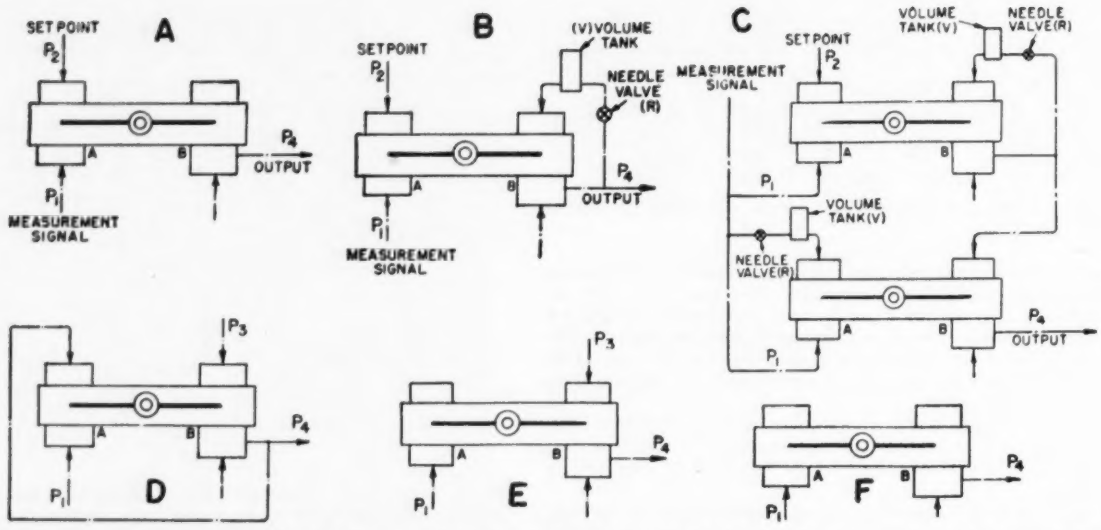


Fig. 9-13. Hagan ratio totalizer, showing A, use as proportional controller; B, proportional plus integral; C, proportional plus integral plus derivative; D, averaging; E, adding; F, multiplying.

diaphragms arranged in opposing pairs. The two elements of each pair are attached to a common post; a beam, rotating about a fulcrum, is connected between the two posts. The beam is positioned by the end posts; the left-hand post is positioned by input signals 1 and 2; the right-hand post is positioned by input signal 3 and the output signal 4.

The resultant force up or down at the left post multiplied by its distance to the fulcrum, or lever arm A (Fig. 9-12), always must equal resultant force at right-hand post multiplied by lever arm B. Hence moving the fulcrum to the right increases the effect of inputs 1 and 2 on the output; motion to the left has the opposite effect. This is the force-balance principle.

Owing to the force-balance principle:

(P4 — P3) (lever arm A) = (P1 — P2) (lever arm B)

Hence

$$P4 = (B/A)\ (P1 - P2) + P3$$

When A equals B:

$$P4 = P1 - P2 + P3$$

This makes possible the various actions of the unit, some of which are shown in Fig. 9-13. In 9-13,A, the difference between set-point and measured signals yields a proportional-action output signal. In 9-13,B, integral action is added to the proportional controller; this application is a clear illustration of the integral action of all pneumatic controllers. Similarly, the way derivative action is added (Fig. 9-13, C) is a clear illustration of a principle applicable to most pneumatic controllers. Fig. 9-13,D shows an averaging circuit—that is, P4 equals (P1 + P3)/2. Fig. 9-13,E shows a simple addition circuit. Fig. 9-13,F is a basic multiplier or divider circuit.

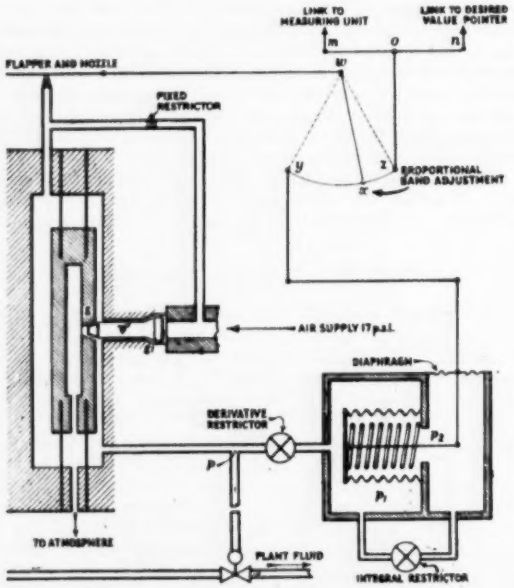


Fig. 9-14. George Kent "Model XX" controller.

George Kent Ltd. (British)

"Mark XX"

The method of generating the actions was previously described (Fig. 8-9 in chapter 8) and is clear from Fig. 9-14. In the "Mark XX" controller, the characteristic feature of the relay valve is the double diaphragm system. When the nozzle pressure falls, the diaphragm system moves to the left and valve v leaves its seat s and closes at s^1. Air from the regulating unit thus bleeds to atmosphere, through the space between the two diaphragms, until p equals nozzle pressure. The reverse process happens when nozzle pressure rises. The valve is thus of the non-bleed type and its amplification is unity, i.e. nozzle pressure is equal to controller output pressure.

Proportional band width adjustment is made by moving x (in the schematic diagram of Fig. 9-14) on the arc xyz.

The deviation is detected by a differential linkage (shown as differential lever mon in Fig. 9-14). It is clear that adjustment of the desired value will not alter the proportional band width (i.e. the ratio yx : xz) if the system is perfectly constructed.

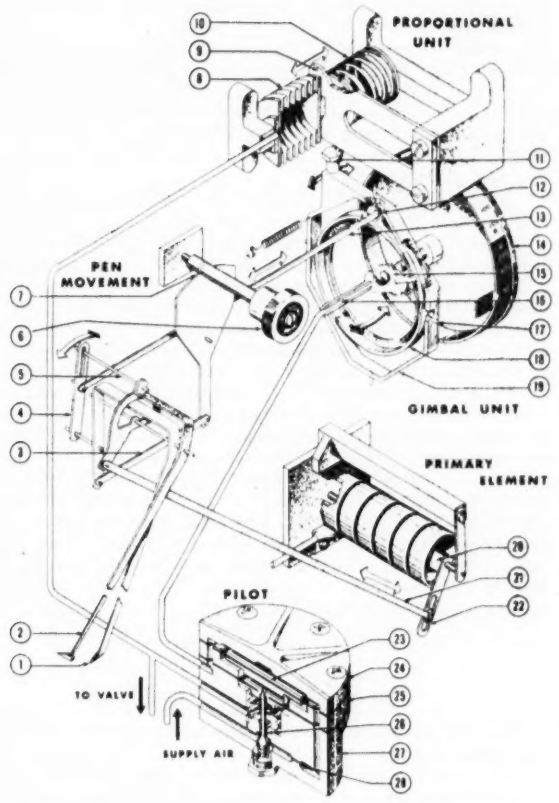
The interaction factor, as has already been shown in Chapter 8, is equal to $[1 + (2r/s)]$.

Mason-Neilan Regulator Co.

"6000 Series" Controllers

Of the several distinctive features of these controllers, there may be singled out the "gimbal unit" which combines primary and "feedback" motions. This gimbal unit has the further advantage of making it possible to generate "differential-gap action" in the same instrument with proportional action without change.

Fig. 9-15 is an instructional drawing of a "6000 Series" proportional-action controller. Proportional bellows 8, which is continuously connected to the output air, positions (through 9 and 11) outer gimbal 19 which pivots about the



1 Set point index	11 Eccentric screw	20 Clamp
2 Pen	12 Universal	21 Element link
3 Index setting link	13 Gimbal link	22 Take-off arm
4 Control lever	14 Proportional band wheel	23 Diaphragm block
5 Pen connector	15 Flapper	24 End plate
6 Index setting knob	16 Nozzle	25 Intermediate plate
7 Friction drive	17 Pivots	26 Pilot plug
8 Proportional bellows	18 Inner gimbal	27 Pilot body
9 Proportional leaf spring	19 Outer gimbal	28 Metering tube (schematic)
10 Proportional spring		

Fig. 9-15. Mason-Neilan "6000 Series" controller for proportional action.

vertical axis. Inner gimbal 18 is suspended in the outer gimbal, by pivots 17, and rotates about a *horizontal* axis.

With flapper 15 in the quadrant as shown in Fig. 9-15, an increase in the controlled variable moves parts 22, 21, 4 and 13 so as to rotate inner gimbal 18 clockwise, causing flapper 15 to cover nozzle 16 and thereby increase output air pressure. (Action of parts 23-28 can be omitted.) The increase in output air pressure expands 8, rotating gimbal 19 about the vertical axis and causing flapper 15 to uncover nozzle 16. Since flapper movement for a 12-psi. change in output air is about 0.001 inch, this system is of the force-balance type. For any position of gimbal link 13 (i.e. any value of the controlled variable) there is only one possible position for proportional bellows 8.

Band-width adjustment: Rotating proportional band wheel 14 shifts the point of contact between the pin on flapper 15 and the bead on inner gimbal 18. This varies the amount of bellows movement required to compensate for movement of gimbal link 13. If the flapper is turned to a vertical position in line with universal joint 12, motion of the proportional bellows will have no effect on the flapper (i.e. minimum proportional band). Intermediate positions of the flapper will produce intermediate proportional bands.

On proportional-plus-integral controllers, the proportional unit is replaced by a "Reset Unit" whose construction differs by the addition of the integral bellows (in place of proportional spring 10 of Fig. 9-15), an adjustable resistance unit and a capacity.

Minneapolis-Honeywell Regulator Co.

The Honeywell-Brown pneumatic controller employs a non-bleed-type relay valve. A second noteworthy feature is a liquid-filled bellows system to generate integral action.

The differential linkage between pen and feedback bellows and the adjustments for changing proportional band width are clear from the diagram, Fig. 9-16. A pressure proportional to the controller output pressure (p) is fed back, via the relay valve, into the case enclosing the right-hand bellows system. Suppose p decreases; then the spring at the left-hand end causes the whole bellows system to be displaced to the right. The rod connecting the ends of the two inner bellows also moves to the right. This movement is proportional to the pressure change and it is transmitted to the differential linkage through pins 1 and 2. The separation of these pins determines the a : b ratio; pin 2 is adjustable; the usual range is 0.2-200 percent band width.

This proportional action is completed before any appreciable flow of liquid can take place through the restrictor, from one liquid-filled space to the other. The spring inside the inner bellows on the right-hand side has been extended, and therefore the liquid on this side will be at a lower pressure than that on the other, and the latter will tend to flow through the restrictor to the right-hand side. This flow causes the rod carrying pin 2 to tend to move towards its initial position at a rate depending on the output pressure change, i.e. on the deviation. Integral action is thus generated.

Derivative action is added by the derivative action restrictor. The effect of the associated capacity (C) and bellows unit is to limit the controller gain and phase advance at short periods; this characteristic would be useful when the plant suffered from rapid short-period random disturbances or the installation was exposed to vibration.

The theoretical equation for the controller shows that the interaction factor is $[1 + (r/s)]$. It does not permit derivation of a general relation between nominal and effective action times. The makers recommend that nominal derivative action time should be set at half nominal integral action time (i.e., $r = \frac{1}{2}s$). For this r/s ratio, the interaction factor is 1.5 and therefore the effective proportional band will be narrower, by this factor, than the nominal value set.

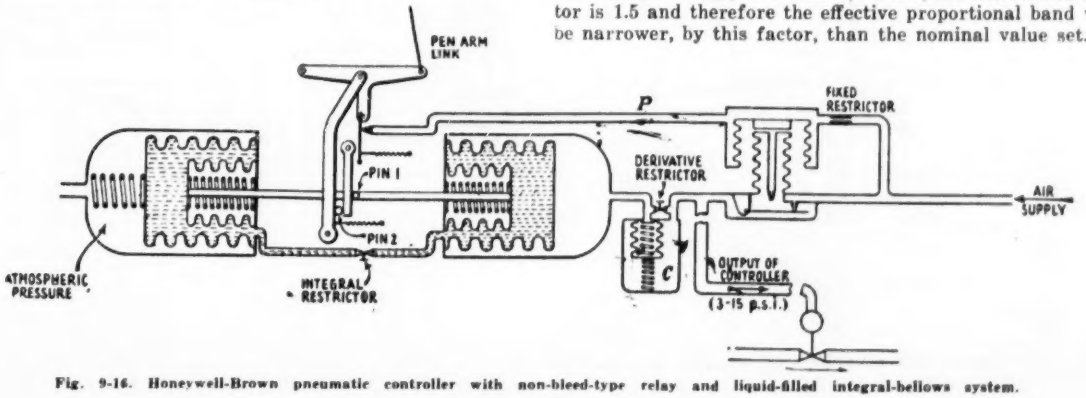


Fig. 9-16. Honeywell-Brown pneumatic controller with non-bleed-type relay and liquid-filled integral-bellows system.

MOORE PRODUCTS CO.

"Nullmatic" Controllers

Mention has already been made of the introduction of "blind" controllers in order to minimize distance-velocity

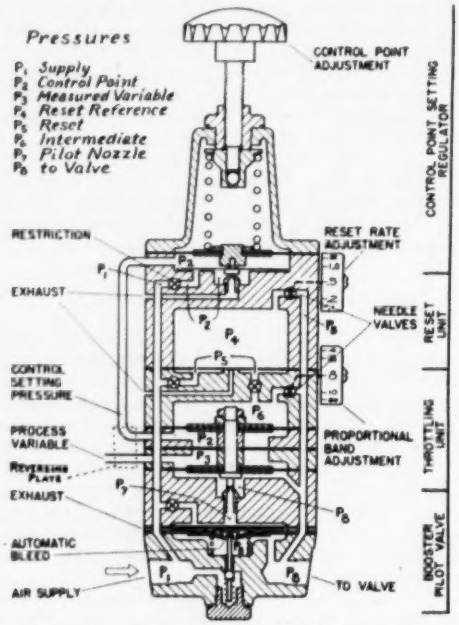


Fig. 9-17. Moore "Nullmatic Model SS" stack-type controller.

lags in large American plants with control rooms hundreds of feet from the processing units. Of these process-located controllers, the "Nullmatic" units were the first (1947) in which a stack of diaphragms and interchangeable parts were used in place of individual bellows-type components—all control actions being generated by balancing air pressures without use of pivots, linkages, or other parts subject to friction.

One of the "Nullmatic" controllers (the "Model SS") is shown schematically in Fig. 9-17. This model operates on the force-balance principle.

When the proportional-band needle valve is wide open, the band-width is minimal and the control action is practically two-position. When this needle valve is fully closed, a 200-percent band-width results from the 2:1 ratio of areas of the P_2 and P_3 chamber diaphragms.

"Reset" (integral) rate—i.e. the rate of change of P_8—is determined by the upper needle valve. The "reset reference" pressure P_4 is reproduced in the reset-pressure chamber through operation of a 1 : 1 relay. When the controller is not in balance, reset-reference pressure P_4 changes at a rate dependent on the setting of the reset needle valve. The

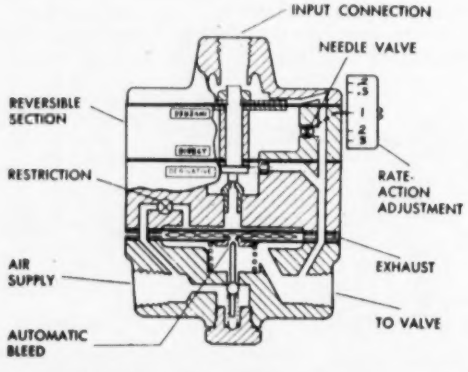


Fig. 9-18. Derivative unit for "Nullmatic" controller, providing both derivative and inverse-derivative actions.

pressure in the reference chamber is raised or lowered, producing the gradual change in P_8 necessary to rebalance the system.

Fig. 9-18 shows a "Derivative Unit" for the "Nullmatic" system. It can be placed in the circuit ahead of the principal controller (one as shown in Fig. 9-17), or following it. With this derivative unit interposed, the result is to narrow the proportional band width as a function of the rate of change of the controller output, i.e. the rate of change of the process variable itself.

"Inverse Derivative."—Noteworthy feature of the Fig. 9-18 unit is the reversible section. When it is placed as shown, the unit generates the usual derivative action; when it is reversed, the unit *widens* the band-width as a function of the rate of change of the process variable. In other words, instead of temporarily narrowing the band-width when there is a process change, the unit temporarily widens the band-width; and instead of causing the output (to the valve) to lead the process, it causes this output to lag the process. For a detailed dissertation on this extraordinary mode of control, see the original disclosure* by C. B. Moore. In the six years since the introduction of "inverse derivative," practically all of the skepticism it met has vanished as its fields of usefulness have become recognized. The most widely recognized of these fields are: (1) liquid flow-rate control, (2) gas flow-rate control, (3) some pressure control applications, (4) some small-capacity liquid-level control applications, (5) some pH and oxidation-potential control applications.

*C. B. Moore, "The Inverse Derivative—A New Mode of Automatic control," *Instruments*, Vol. 22, March 1949, pages 216-219.

NEGRETTI & ZAMBRA (BRITISH)

The Negretti & Zambra controller is designed to eliminate interaction between the control actions. The manner in which it does so will be seen from Figs. 9-19 and 9-20. Proportional and derivative and proportional and integral actions are generated and added. At the same time proportional action is subtracted. Experimental tests show that the interaction factor is in fact unity.

Eliminating interaction benefits the user in two ways: (1) the controller is easier to set up since actual *effective* action times are as set on the dials; (2) the phase advance obtainable if required is not limited by the effect of interaction. It will be remembered that the amount of derivative action (and hence of phase advance) which can be used depends on the form of the interaction factor.

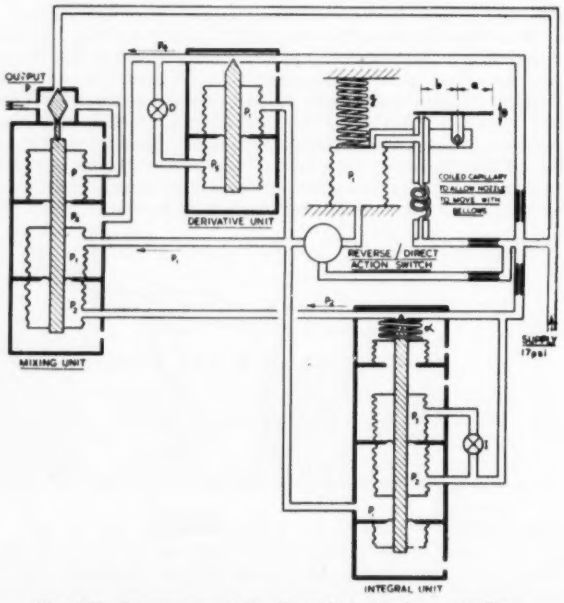


Fig. 9-19. Components of the Negretti & Zambra controller.

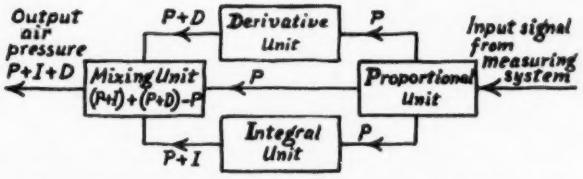


Fig. 9-20. Block diagram of Negretti & Zambra controller, showing separate derivative and integral units.

Experiment shows that the limitation on phase advance obtainable in practice is set by the impedance of the air valve in the mixing unit. For periods less than about 3 minutes, the phase advance obtainable falls below theoretical to about 50 degrees, depending on the capacity in the output. It should be noted that this is a high value and that by modifying the value concerned much higher values can be obtained. At present it would be unusual, however, to require higher values for normal plant requirements—and if required for special application a low input capacity booster could be used to transmit output pressure to the regulating unit. Phase advance of 60° to 70° could then be obtained.

A feature of the Negretti & Zambra controller is the "plug-in" construction of subassemblies such as the compact integral and derivative units. The controller is at present made for use with mercury-in-steel thermal systems or other measuring elements giving a pressure or mechanical output.

Republic Flow Meters Co.

The Republic Regulator is a force-balance controller operated by either pneumatic or hydraulic pressure. This description is based on pneumatic operation, but the principle is the same for hydraulic operation.

As shown in Fig. 9-21, pressure from some process vessel or line is applied to a measuring diaphragm. When the force thus created overcomes the force of the setting weight (or setting spring), the weighbeam moves on its pivot, tending to shut off the air bleeding from the nozzle and building up a back pressure under the amplifier diaphragm. The amplifier *starts* to move upward. In doing so, it pushes the weighbeam away from the nozzle, reducing the back pressure under the diaphragm. Pressure builds up under the amplifier diaphragm just enough to balance the downward force of the measuring diaphragm. The weighbeam will be held at just the distance from the nozzle necessary to produce a balance of all the forces involved.

(The motion of the weighbeam required to produce full pressure change in the amplifier is less than 0.004 in. so that, from a practical standpoint, the measuring diaphragm need not move to produce full regulator action.)

Control Actions.—The link between the amplifier and the weighbeam can be either a spring, a dashpot, or both (as in Fig. 9-21). When only a spring is used, the force-balance principle produces only *proportional-position* control action. When only a dashpot (piston in oil-filled cylinder) is used, *proportional-speed floating* action is obtained because the piston moves at a rate proportional to the deviation from balance. Speed of piston movement is varied by changing the by-pass orifice.

When both the proportional spring and the dashpot are used, as in Fig. 9-21, the control action is *proportional plus integral*—that is, upon deviation of the variable, the amplifier immediately moves an amount proportional to the deviation and then moves at a rate proportional to the deviation.

Additional Amplification.—When power required to operate valves and dampers is more than the amplifier can supply, a pilot valve and power cylinder are added to the controller, as shown on the right in Fig. 9-21.

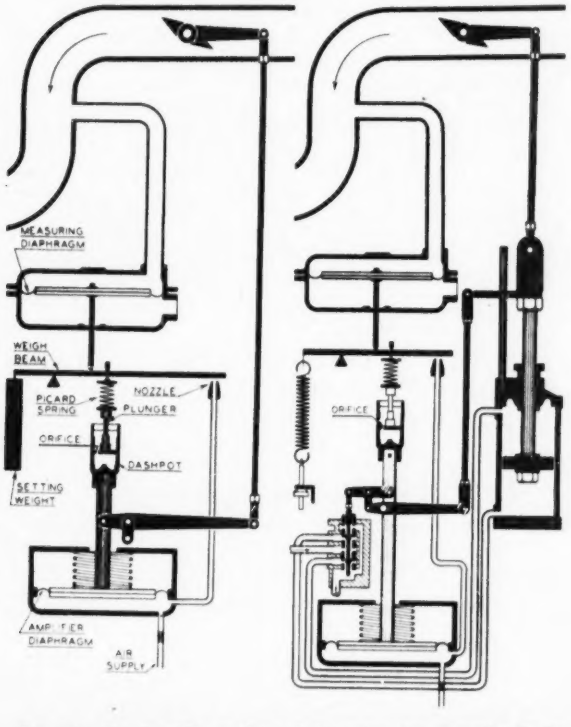


Fig. 9-21. The Republic regulator. Left, system for proportional plus integral control action; right, controller plus power cylinder.

Taylor Instrument Companies

1. *"Fulscope" Controller*

This instrument is interesting on account of the different mechanical arrangements used for changing its characteristics and the method employed for combining the integral and derivative actions.

In most instruments examined so far, the integral and derivative restrictors have been placed in "series"; in the Fulscope they are in "parallel." This leads to different characteristics, as will be seen below.

The "flapper" consists of a cylinder carried on a lever. This lever is pivoted on a disk, which can be rotated to alter flapper/nozzle separation, and hence to adjust the desired value. The end of the lever is moved by the measuring unit. It will be noticed that the measuring unit can move the pen freely past the position at which the cylindrical "flapper" rests on the nozzle.

The sensitivity reduction required in a wide-band controller is obtained by a normal bellows feedback unit with a characteristic linkage for varying proportional band width, Fig. 9-22. (c). In the designs previously discussed, the "feedback" was arranged to decrease the flapper move-

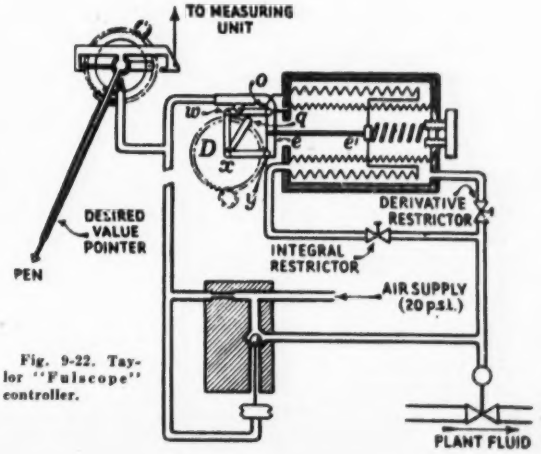


Fig. 9-22. Taylor "Fulscope" controller.

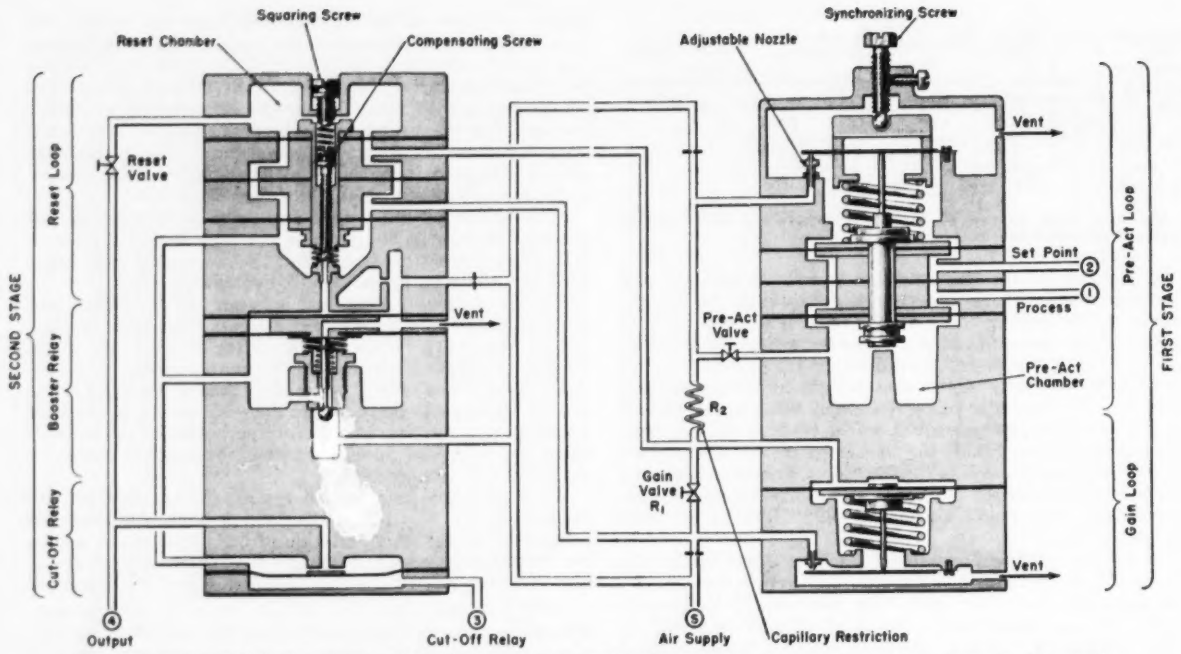


Fig. 9-23. Taylor "Tri-Act" controller. Although shown in two units, the controller is a single unit, as shown in Fig. 9-24.

ment due to a given pen-arm movement, by means of a differential linkage. In this design, the nozzle is moved directly by the feedback system, as shown in the figure.

The proportional band is varied by adjusting disk D, which adjusts the effect of the feedback bellows. As q is moved towards y (Fig. 9-22), the feedback increases and the band widens. The normal range of adjustment is from 0.25 to 250 percent.

The "parallel" arrangement of derivative and integral action leads to an interaction factor of $(s + r)/(s - r)$, which is the easiest form to remember, or $[1 + (2r)/(s - r)]$, which is the more convenient. For many conditions a setting of $r/s = \frac{1}{4}$ will give satisfactory results: the interaction factor at this setting will be 1.67 and the derivative action will give a phase advance of about 40°, when nominal integral action time is set to 1/1.67 of operating period.

2. *"Tri-Act" Controller*

The "Tri-Act" control circuit, Fig. 9-23, consists of two stages with three pneumatic loops connected in series and contained in one compact unit. The first stage embodies an adjustable proportional band with derivative action; the second stage employs a fixed proportional band and "automatic-reset" type of integral action. By providing derivative action in the first stage of the instrument, ahead of integral, this controller gives automatic start-up without overpeaking—advantageous on batch processes and on continuous processes that have occasional shut-down.

In the first stage of the controller, the transmitted process pressure and the desired-value ("set-point") pressure oppose each other. When these are equal, the pen and the desired-value pointer are together (process at control point).

If a load change occurs in the process to increase the transmitted pressure to the controller, then this action unbalances the stack in the first stage and moves it down. As this happens, the baffle approaches the nozzle and its back pressure, which is the output of the derivative-action loop, increases. The derivative valve (marked "Pre-Act") offers a restriction to the flow of air to the "Pre-Act" chamber and delays the balancing action in the first stage. As a result, the first stage output pressure is higher for the period of time it takes the chamber to fill to the balance pressure. This is the derivative-action time.

The output of the derivative-action stage bleeds through the capillary restriction to the proportional-action stage (marked "Gain Loop"). This causes a pressure increase on top of the diaphragm and drives the baffle away from the nozzle. The nozzle back pressure decreases and is the output of the "gain loop." This output decreases the pressure on top of the diaphragm to its original value.

The "gain loop" output feeds the second stage of the controller where it is opposed by the balance pressure of the same loop. Because of a differential in these two pressures, the stack of the "reset loop" moves down. As this occurs, the ball approaches the nozzle and the nozzle back pressure increases to force down the "booster relay stack" (middle, left). As this happens, the booster relay output pressure increases. This is the output air pressure of the controller and also travels to the bottom of the "reset" stack to balance it. At the same time, this output pressure goes through the reset valve (upper left) to further reposition the stack and increase the output pressure of the controller. The rate at which the air goes through the valve to the reset chamber is the integral-action rate.

Fig. 9-24 shows the flexibility of the modern control system. The transmitters adapt the controller to any desired process variable. The controller can be mounted where lags are at a minimum. Miniature graphic-panel-type or conventional-size indicators and recorders can be mounted on the control board. Several manufacturers offer these flexible lines comprising pickup-transmitters, controllers, and panel indicator-recorders.

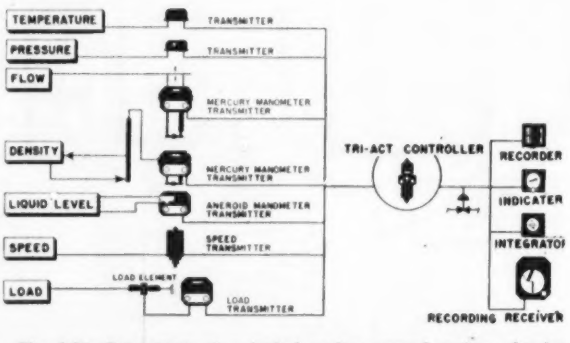


Fig. 9-24. Components of a typical modern control system, showing flexibility of applications. Transmitters and controllers can be mounted at optimum locations.

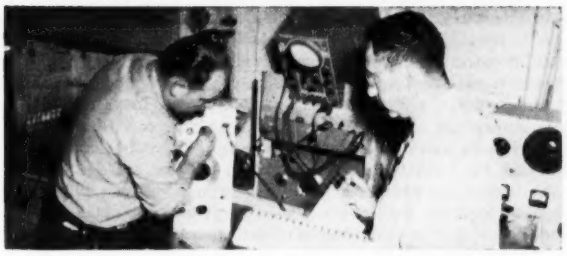


Fig. 1. The oscilloscope is a basic test instrument.

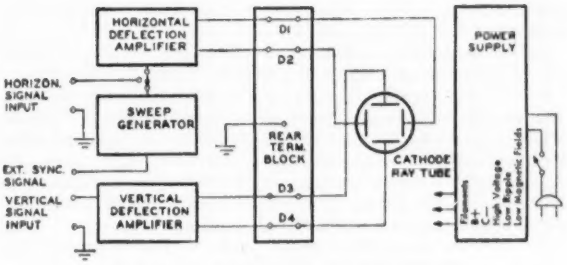


Fig. 2. Block diagram of an oscilloscope.

Use and maintenance of OSCILLOSCOPES

Five basic uses of the oscilloscope permit a wide variety of important applications. Detailed service procedure is presented.

by JAY DOBRIN
Western Scientific Co.

OSCILLOSCOPE is one of the most useful tools in the laboratory or instrument department. It combines the functions of several instruments and can perform a variety of tasks.

The oscilloscope has five basic uses—(1) observation of waveform, (2) measurement of frequency, (3) measurement of phase, (4) measurement of voltage, and (5) measurement of time.

The primary use is observation of waveform; signals can be traced through a circuit and sources of distortion can be found merely by observing the signal at various points in a circuit.

Another important use is the determination of the *frequency* of an unknown signal by comparison with a signal of known frequency. For this application no sweep signal is used. The known signal is applied to one set of deflection plates and the unknown is applied to the other set. Fig. 3 shows patterns for various ratios of frequencies. Note that the ratio of frequencies is found from the number of times that the waveform reaches a maximum in horizontal and vertical directions.

When two waves of the same amplitude and frequency are applied to the deflection plates, variations in *phase* between the waves produce the patterns shown in Fig. 4. The phase relation of the signals is observable from the pattern.

The oscilloscope can be used as a *voltmeter* for d-c. or a-c. signals by calibrating the deflection-plate sensitivity or deflection amplifiers.

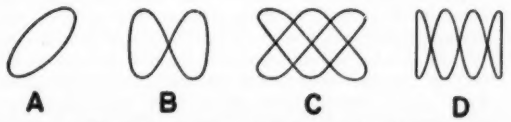


Fig. 3. Lissajous patterns produced when signals of different frequencies are applied to the two deflection systems. Ratio of frequencies in A is 1:1, ratio in B is 2:1, ratio in C is 3:2; ratio in D is 4:1.

For *time measurement*, the linear horizontal sweep is used. As the sweep is a linear time base, the duration of signals as well as the duration between signals can be measured. This time-measurement function is the heart of the radar, in which the time for a pulse to travel from radar transmitter to target and for the echo to return to the radar receiver is indicated in terms of a displacement of a signal on the face of a cathode-ray tube. This also is the principle of ultrasonic thickness gages.

Some jobs performed regularly by oscilloscopes (with auxiliary apparatus) are: Measurement of phase shift across electric wave filters, measurement of bias distortion of teletype signals, measurement of inductance to 0.1 percent when used with precision capacitors, null-detector indicator, measurement of distortion in amplifiers, measurement of the Q or dissipation factor of capacitors, measurement of reflected impedence, measurement of voltage-

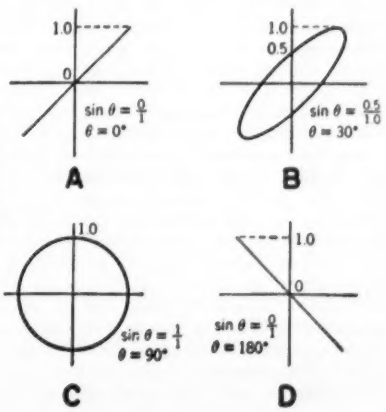


Fig. 4. Patterns when signals of same frequency but different phase are applied to the two deflection systems. A, phase difference is 0 deg.; B, phase is 45 deg.; C, phase is 90 deg.; D, phase is 180 deg.

ratio of transformers, adjustment of decimal counting unit, frequency monitoring, etc., etc.

If not maintained properly, oscilloscopes develop troubles which show up in failure of the instrument to provide:

1. *Correct sensitivity (gain).* Correct sensitivity permits the oscilloscope to be used as a vacuum-tube voltmeter when the manufacturer of the instrument has specified its sensitivity in inches deflection per rms. volt.
2. *Correct frequency response.* Most modern oscilloscopes have useful sensitivity to above 200 kc.; special pulse oscilloscopes operate flat to several megacycles.
3. *A fine, pencil-thin trace.* This is indispensable for critical measurements of inductance, capacitance, dissipation factors, phase shift, and distortion.
4. *Freedom from drifting pattern or microphonics.*
5. *Proper operation of sweep and focus controls.*
6. *Adequate re-trace suppression and linearity of sweep.*
7. *Pattern of ample intensity,* which should be seen clearly in areas of high ambient light.

Routine Service

Preventive maintenance guide for oscilloscopes is presented in step-by-step form. It normally should be followed in sequence. Oscilloscopes should be scheduled for service quarterly.

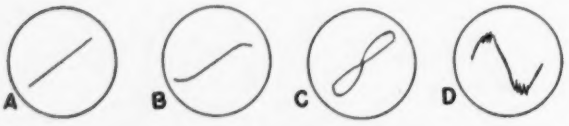


Fig. 5. Typical patterns. A, normal 0-degree phase-shift pattern; B, same as A, except oscilloscope has distortion in vertical amplifier, caused possibly by overloading; C, same as A, except signal has second-harmonic distortion; D, sinoidal signal with superimposed noise, originating either from outside the instrument or from noisy tubes within.

Remember always that all cathode-ray-tube equipment employs high voltages which can be fatal. As a preliminary step to all servicing, the "intensifier" terminal of the cathode-ray tube should be grounded.

Step 1. Renewal of Vacuum Tubes

Vacuum tubes are renewed first in the service procedure to permit adequate warmup or aging of tubes.

A. Tubes should be renewed when their conductance falls to 60 percent of their rated mutual conductance.

B. *Vertical-* and *horizontal-amplifier-stage* tubes should be replaced one-at-a-time. This provides assurance that each new tube installed is not microphonic. It may be necessary to try several tubes to obtain low microphonics or noise in the amplifiers.

C. Make sure that shock mounts are free and that wiring is not restricting the motion of the shock-mounted chassis. Such restriction can increase microphonics and prevent measurements of complex waveforms, because the pattern can be modulated by signals caused by microphonics.

D. Tubes for the vertical- and horizontal-amplifier circuits should be selected for minimum microphonics. The following procedure is recommended:

Vertical amplifiers: Advance vertical gain to maximum. Set vertical input signal attenuator at minimum attenuation. Put a short circuit across vertical input terminals. Introduce enough horizontal signal to give a one-inch line. Renew vertical amplifier tubes one-at-a-time starting with the first or input stage. Tap carefully for microphonics, which show up as vertical deflection of the pattern when the tube is struck. In many oscilloscopes the first vertical amplifier is between the vertical attenuator and the vertical gain control. This simplifies the task of isolating microphonic first-amplifier tubes because such a tube will show microphonics upon the screen with the vertical gain control advanced but will not show microphonics with this control at a minimum.

Horizontal amplifiers: Advance horizontal amplifier for maximum gain. Disable sweep circuit. Place a short circuit across horizontal amplifier input. Provide enough vertical signal from the internal sixty-cycle-signal test point (on front panel of most oscilloscopes) to give a line one-inch high. Renew successive horizontal-amplifier tubes as recommended for vertical-amplifier tubes.

E. Tubes removed from amplifier stage because of microphonics can be utilized in sweep circuits, where microphonics, if not severe, will not impair operation of the instrument.

F. Rectifier tubes should be tested in a tester which operates the tube under load. If your tube testers do not provide an emission test, a criterion for emission can be set up by testing about 10 new, good tubes, first at rated filament voltage and then at about 90 percent of rated filament voltage. Generally, if mutual conductance drops 20 to 25 percent when the filament voltage is reduced by 10 percent, tubes have low emission and, consequently, short life expectancy.

H. The cathode-ray tube should be renewed when it becomes microphonic or shows signs of low emission, as indicated by lack of trace intensity. Oscilloscopes operated for long periods with spot in a fixed position often will have a burned screen. If this impairs operation, the CR tube should be renewed.

Step 2. Physical Check

A. Inspect for loose connections. A tube socket connection may have been left unsoldered at the factory. Changing a tube can dislodge the socket from contact and cause intermittent operation. TRY TO LOOK AT EVERY CONNECTION.

B. Look for overheating components, for signs of discoloration of resistor color codes. Look at ceramic by-pass condensers for "smokiness." Feel power transformer for overheating.

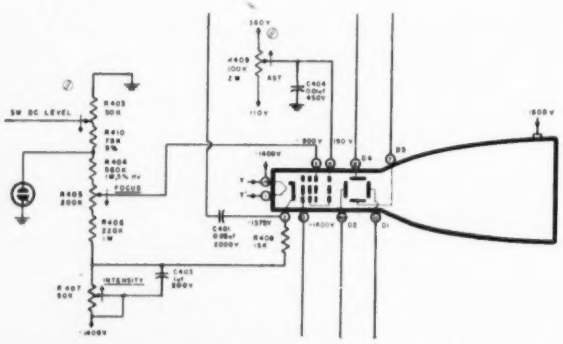


Fig. 6. Electron-gun circuit, including focus and intensity controls, of DuMont "Type 304-A" oscilloscope.

C. Look for signs of misuse. Renew broken binding posts. Clean inside and out. Clean the screen and mask. Tighten screw-terminals at the rear of the oscilloscope.

D. Check the power cord and renew if frayed. Tighten knob set-screws. Renew the pilot lamp if necessary. Check fuse for conformance to the manufacturer's rating.

Step 3. Test and Correction for Thin Line

A. With all gains at maximum and inputs shorted, there should be no deflection in either axis. If no noisy tubes have been installed, deflection in either axis (Fig. 5) will be caused by an extraneous 60-cycle or 120-cycle noise signal entering the amplifiers. Adjustment of the sweep controls will "stop" the pattern and permit identification of the noise frequency. If 60-cycle noise, the defect can be (1) cathode-filament leakage in a tube, (2) hum pickup from filament wiring, or (3) ripple in a half-wave rectifier circuit, possibly caused by low capacitance or poor

power factor in an electrolytic filter capacitor. If 120-cycle noise, the trouble is in the full-wave-rectifier circuit and usually is electrolytic capacitor trouble. If not any of the above, the voltage regulator tube can be at fault; replace the VR tube and gas-triode in the sweep oscillator, or both.

B. If the line is thick and will not focus, the trouble is astigmatism, caused by change with age of the resistance value of resistors in the high-voltage string (shown in Fig. 6). This may be corrected by adjustment of the potential applied at Anode 2 and Grid 2 (pin 9) of the cathode-ray tube. Limiting resistors in series with the focus pot should be checked. Check and replace all resistors that have changed value.

Step 4. Run-in and Final Check

A. Check the output voltage of the *regulated power supply;* it must be as specified in the instruction book. This should be tested from 90 to 130 line volts unless the oscilloscope is known to be operated at certain specified line voltages. (A "Variac" or "Powerstat" is needed to perform this test.) Run in for at least 20 minutes. Some typical patterns and probable causes of trouble are given in Fig. 5.

B. *Set the sensitivity.* Using a secondary standard of voltage, such as a thermal-voltmeter, with about 1 percent accuracy, feed 1.0 volt at 1000 cps. to both X and Y inputs. Adjust the controls as specified by the instruction manual for proper horizontal and vertical deflections. Gain controls must be on specified settings.

C. *Check the frequency response.* With a variable-frequency oscillator, feed input signals from about 100 cps. to 150 kcs. (or whatever the upper frequency limit of the

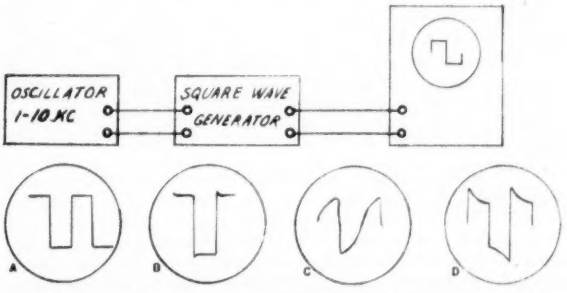


Fig. 7. Use of square-wave generator to check and adjust frequency response. A, proper response; B, compensation close to normal; C, poor high-frequency response; D, poor low-frequency response.

oscilloscope may be) to both horizontal and vertical amplifiers. Use a vacuum-tube voltmeter with a known frequency response or a thermal voltmeter to monitor the input signal. Adjust the trimmer capacitances in the input attenuators of each amplifier to flatten the frequency response at each setting of the input attenuators. If a square-wave generator is available, it is preferable to perform these adjustments as shown in Fig. 7.

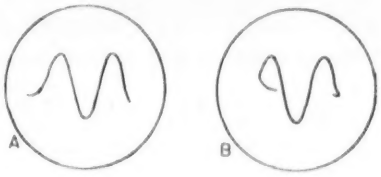
D. *Adjust d-c. balance controls, and X and Y positioning controls.* If tubes have been installed which have large inter-triode unbalances, the balancing controls provided may not permit balancing the oscilloscope or centering the picture. Thus it is important that all paired tubes used in the amplifier stages be matched. This can be done on a tube tester by selecting tubes which are within 10-percent mutual conductance after aging. Similarly, when renewing "paraphase amplifiers" to drive the deflection plates of the cathode-ray tube, it is important that the two tubes (usually 6V6's or 6AQ5's) be chosen in matched pairs. Here again, matching usually can be done on the tube checker. Check the single-sweep sync adjustment as outlined in instruction manuals. Continuous, proper operation cannot be guaranteed unless each tube in the amplifier is aged at least 24 hours prior to selection and installation.

E. Check *sweep signal frequency* for conformance to knob setting. In oscilloscopes having a sawtooth test signal available on the front panel, this signal can be fed into an events-per-unit-time meter (or other frequency meter) and read directly. If *all ranges* are incorrect, correction can be accomplished in the "R" branch of the RC sweep circuit; if only individual ranges of sweep frequency are off, correction can be made in the appropriate "C" branch of the same circuit. Another test method is to adjust sync to near zero, feed a known signal, stop the pattern, and compare sweep range and sweep vernier knob settings with the frequency of the known signal.

F. *Re-trace blanking* is out of adjustment if pattern appears as in Fig. 8. An adjustment capacitor usually is provided in the circuitry.

G. *Final service.* Run all panel controls through complete range of rotation. If noisy or intermittent, clean and service with a proprietary control-service preparation, and apply a small amount of lubricant. Service attenuator switches. Most noise and intermittent operation in rotary switches and potentiometers is caused by the central "slip-

Fig. 8. Examples of inadequate re-trace suppression.



ring" commutator point. Put cleaning preparation at the center rotating contact; the wiper arm is secondary point of trouble.

Step 5. Recording Data

Enter service performed; indicate tubes and components replaced; enter data on the record. See that records indicate the location of the oscilloscope for the next service period.

Manpower and Parts Requirements

A. For 100-200 oscilloscopes, it is estimated that maintenance requires between five and six man-hours of shop labor time per oscilloscope per year.

B. For 100-200 oscilloscopes, it is estimated that tube renewal will be at a rate of 11.1 tubes per oscilloscope per year. (This is for two-shift continuous operation and for various types of oscilloscopes.) For intermittent or laboratory use, where oscilloscopes are used four to eight hours daily, the tube demand is reduced to 60 percent of the above, or 6.7 tubes per year.

Operation

Operating the oscilloscope near a large power transformer, a line-voltage stabilizer or other large electromagnetic field will cause deflection of the amplifiers, fuzziness of pattern, spurious 60-cycle deflection, and abnormal results.

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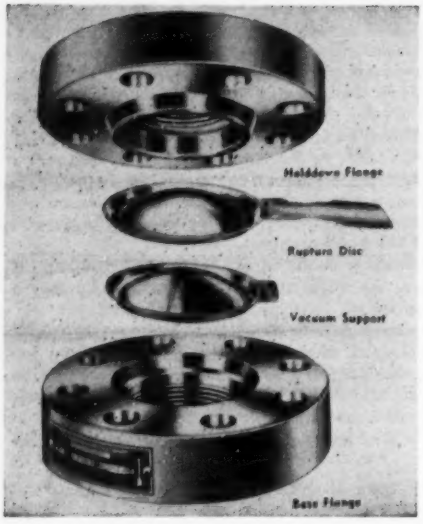


Safety-disk assembly of Black, Sivalls & Bryson Co.

SAFETY DISKS

by CARL J. HOLINGER
Bakelite Company

Users can make safety-disk pressure reliefs by proper choice of material and by constructing the disks in accordance with a few simple calculations and adequate proof tests. A complete program is presented. This is the First Prize winner in the ISA New Jersey Section papers contest.

PROTECTION of pressure vessels against over-pressure usually consists in specifying a safety valve. In the chemical and oil industries, however, a safety valve can be cemented shut by the product, can corrode shut or open, or can become unreasonably large to satisfy fire conditions. Therefore, an alternate is highly desirable.

The alternate permitted by the various codes is the use of a safety disk. There are a few commercial manufacturers of safety disks and they make a good, fail-safe product; but the limitations most manufacturers have placed upon their product have lessened its value to the point where a user must often make his own safety-disk equipment in order to make fullest use of his process equipment. It is not difficult, for example, to eliminate entirely the 8½ to 21 percent "manufacturing tolerance" required by one manufacturer; nor is it necessary to be bound to the limited selection of stock disks offered by other manufacturers.

The literature on safety disks is likely to be confusing to the inexperienced because there is considerable discussion on the general problem of calculations, and there are few specifications on details of construction. Calculations are of secondary importance in safety-disk work; they must always be confirmed by experimental bursts in the size holder to be used in the field. The lack of details of construction can probably be explained by the fact that the details of one type are so simple that no one has thought it necessary to give them; others are patented; some are company secrets.

Types of Safety Disks

There are four general types of safety-disk designs, two of which have sub-types.

1. *Shear Bursters* are probably the oldest type. They are used extensively on gas shipping cylinders and are favored by a part of the chemical industry for higher pressures[1] (over 1,000 psi). They can be divided into the *flat-sheet design*, for small burst diameters of about one-half inch and less, and the *reinforced-center* (Linde)[2] design. In the flat-sheet design the requirement of a smooth sharp holder (resharpened after every burst) presents a maintenance problem that is hard to check easily, and the penalty of rounded corners is a high burst pressure which, of course, is unsafe. The narrow machining tolerance inherent in the reinforced-center design requires a high degree of manufacturing supervision and a considerable investment in special tools for good results.

2. *Flower Bursters* are used almost exclusively at the lower pressures and, in the opinion of many, are as useful for high pressures as are the shear type. There are three designs in the flower-burst type—flat disk, formed disk, and grooved-formed disk. The flat-disk design is the easiest to make, it gives reproducible results easily, and is described in detail. The formed-disk design has been developed and patented by the Black, Sivalls and Bryson Co. The grooved-formed-disk design developed by Lake and Inglis[3] is mentioned for completeness, because the grooving requires special machinery and the burst pressure is admittedly not easily reproducible.

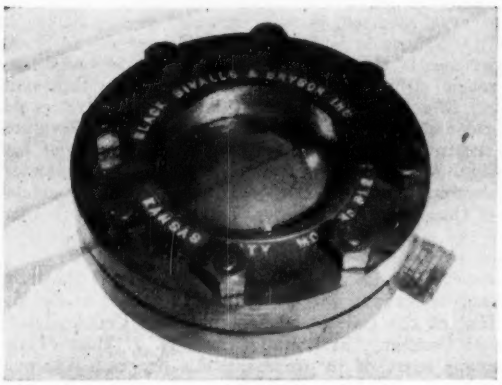
3. *Frangible Disks* is a name that must be used for one type, even though some people use the name for all safety disks. In recent literature Biegler[4] claims good reproducibility of burst pressure for cast-iron disks of a special design. Little is known about them and they cannot be recommended until other users have had experience with them.

4. *Remote Break* disks have been designed and patented by the Mathieson Chemical Co.[5] and licensed to the Chlorine Institute for use on chlorine tank cars. In this design the disk is merely a seal with no appreciable burst strength. The pressure load on the seal is transmitted by a yoke to a necked pin which, when stressed to its ultimate strength, will break at the neck and release the stress-transmitting yoke. Pressure easily breaks the seal and pushes aside the yoke to relieve the pressure in the vessel. Machining the neck of the pin is probably as critical in this type as the machining of the reinforced-center shear-type disk.

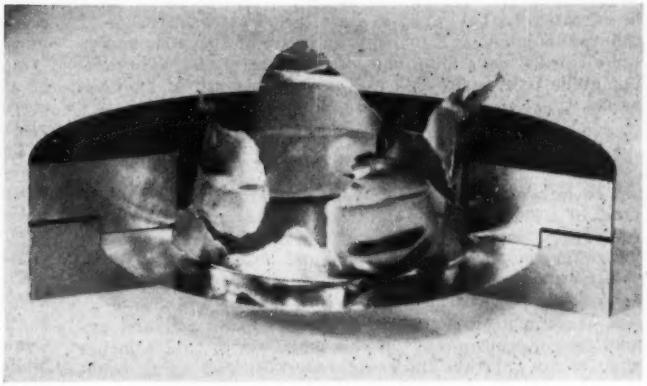
Calculations

Safety-disk area required for the relief of pressure (if there is no explosion hazard) is the same as the pipe area required to release pressure in the vent system. If the burst diameter is at least as large as the inside diameter of the pipe, the safety disk is just part of the pipe run. If the burst diameter is smaller than the inside diameter of the pipe, burst diameter may be treated as an orifice in the pipe.

Four major factors affect burst pressure—material, temperature, burst diameter, and thickness. Material is discussed in detail. Temperature affects the strength of all metals differently: nickel is not much affected by temperatures up to 150 deg. C., whereas silver loses much of its strength in that range. However, it is impossible to calcu-



Assembled safety disk. (Courtesy Black, Sivalls & Bryson Co.)



Ruptured safety disk. (Courtesy Baker & Co., Inc.)

late the burst pressure at one temperature from the results at another temperature, even with the help of temperature vs. tensile-strength curves. The effect of temperature can be determined only by an experimental burst at the desired temperature.

The burst-diameter calculation equation was worked out very thoroughly by Bonyun[6]. No one has improved on the simplicity or accuracy of his work, though there have been many futile attempts to pursue an approach he wisely avoided. Bonyun's equation is

$$PD = C$$

in which P is burst pressure, D is burst diameter, and C is a constant for the piece of material from which the disk is made.

The effect of disk thickness on burst pressure easily leads to confusion owing to the disk material. Considerable effort has been expended to relate the C in Bonyun's equation to one of the standard physical properties such as tensile strength, hardness, etc., but these efforts disregard the fact that fabrication procedures can change the physical properties of some materials by ten or more percent. Even when fabrication procedures are closely controlled, two thickness formulae are needed, depending on material thickness. Thielsch[7] found that for thick materials a unit bursting factor (Ubf) can be obtained from the equation

$$C/t = Ubf$$

if thickness (t) is measured in thousandths of an inch. He reports the Ubf of 2S aluminum thicker than 0.020 inch is 45.5. Bonyun gives a series of curves for the change in C with thickness in the range from 0.002 to 0.012 inch. These curves follow the equation

$$C = Nt - k$$

where N and k are properties of the material. Values of N and k for materials discussed are:

	aluminum	*copper*	*nickel*	*silver*	*platinum*
N	50½	118	227	123	131
k	60	15	155	117	146

These values are included as a guide: for actual disk calculations the C value of material on hand and tested must be used.

Safety-disk Materials

The various pressure-vessel codes require us to predict burst pressure within 5 percent for any disk. Therefore, it is necessary to use homogeneous materials in which the physical characteristics are sufficiently constant over large areas to get closely reproducible burst pressures. Homogeneity is obtained by decreasing the number of phases present in the material (preferably to one), and by having uniform temper throughout. Homogeneity is found in pure elements (as opposed to alloys) and in the annealed condition (as opposed to cold-finished or hard tempers).

Enough work has been done on glass, ceramics, and plastics to demonstrate that they are not suitable for disk material. Elastomers (rubber, silicones, teflon, etc.) have been used successfully as corrosion-protection diaphragms for disks that carry the pressure load. Some literature cites the use of brass, bronze, monel, stainless steel, and other alloys, but none of the alloys give results as consistent as do the elements.

The physical characteristics most sought for in safety-disk material is a high ratio of yield point to ultimate strength. Process operating pressure must be equivalent to the strength of the disk at disk-material yield point, and the code "working pressure" of the vessel must be at least equivalent to disk-material ultimate strength. The ratio of process operating pressure to code "working pressure" therefore is determined by the ratio of yield point to ultimate strength of the disk material. The best materials permit a ratio of operating-pressure to "working pressure" of 0.5 for continuous processes and for storage vessels, and as high as 0.65 for batch processes where it is possible to change disks after definite intervals. Ratios higher than 0.65 seldom are justifiable because disk life is so short.

Metals with low yield-ultimate ratios are zinc, lead, and tin; they should not be used as disks, but they sometimes make good corrosion-protecting diaphragms under disks.

Metals with high yield-ultimate ratios are aluminum, copper, gold, iron, nickel, platinum and silver; all are used and some are surprisingly economical.

Safety-disk Holders

The variety of safety-disk clamping devices has been limited only by the ingenuity of those who have made safety disks; no outstandingly best device has been made. Among the devices used have been: companion flanges, flat rings, and recessed rings in many shapes. The companion flanges are a poor clamping device if only because it is impossible to change burst diameter to get the burst pressure desired. The use of companion flanges to hold a pair of clamping rings, however, makes a convenient flexible installation in which it is easy to change disks.

The simplest clamping device is a pair of flat rings which, because they are to be installed between companion flanges, should have an outside diameter just small enough so that the flange bolts will position the rings. Inside diameter is, of course, burst diameter. The pressure-side ring may be of any thickness consistent with rigidity, and the vent-side ring must be thick enough (especially where large burst-diameters are used in small pipes) so that the bulged disks never will touch the vent-side pipe. There is one critical point in the shape of these rings (or any other type of clamping rings)—the edge of the vent-side ring where the burst diameter meets the disk clamping face. At this point the flat safety disk undergoes tremendous distortion as vessel pressure bulges the center of the disk and the clamping rings hold the disk rim flat. If the edge is sharp or nicked, it will produce tear bursts which will give erratic burst results: if it is rounded too much the disk will

be stressed on too large a diameter. The exact value of this radius is not as important as is use of the same radius for all disks made from one lot of material. A good working guide is to make this radius one-sixteenth of an inch, or ten times the disk thickness, whichever is larger.

Safety-disk Program

The information given may be summarized by the proposal of a simple and straightforward user program which, for process industries with up to 4-inch pipe and 200-psi. "working pressure" equipment would be as follows:

1. Choose aluminum, copper, or nickel, depending on corrosion conditions.
2. Have a precision metal-rolling company roll and anneal five or more pounds of this metal six to twelve inches wide to an accurate thickness (as calculated using equations herein) in one continuous strip.
3. Make a pair of rings, such as described above, with a burst diameter of four inches, or, if required vent areas have been calculated for an installation, then with a burst diameter approximately equal to what is needed.
4. Proof test (burst) three disks in these rings to determine the C value of the material.
5. Recalculate the burst diameter for the pressure desired and make another pair of rings with the calculated diameter.
6. Proof test the material in the new rings with at least two bursts.
7. If burst diameter calculated in step 5 is too large for the width of the strip material, it will be necessary to have thicker material rolled; if burst diameter is too small for the vent area required, thinner material or two disks (in parallel) will have to be installed on the vessel.
8. Corrosion of the disk by the product in the vessel may be overcome either by facing the disk with a thin noncorroding film or by purchasing noble-metal (silver, gold, platinum) disks that have been rolled to definite C values.

The one inviolable rule in safety-disk work is *proof test everything*. A new lot of material, a new burst diameter, a new combination of disk and diaphragm, or any combination of these, must each be proof tested.

Acknowledgement:

The experience needed to assay the content of the literature used in devising this program was gained under Mr. E. R. Hill at the Calco Chemical plant of the American Cyanamid Company, in Bound Brook, N. J. Most of the bibliography searched in preparing this program was provided by Mr. A. J. Lincoln of Baker and Company, Newark, N. J. The author wishes to thank these men and their companies.

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Second Prize Winner

Application of the THREE-WAY CONTROL VALVE

Three-way control valves permit simplification of many temperature-control problems involving by-pass flow. Proper sizing of the three-way valve can be accomplished by comparison of flow-lift characteristics of two-way and three-way valves, using the proved techniques for the former in sizing the latter. This is the second-prize winner in the ISA New Jersey Section papers contest.

by LEONARD HOLLANDER

Standard Oil Development Co.

THREE-WAY CONTROL VALVE has possible wide application in the petroleum-refining industry as a cheaper, simpler, and safer means of heat exchanger by-pass control than is possible with conventional arrangements employing two-way valves. However, in using the three-way control valve the question arises as to what pressure drop the valve must absorb for good process control.

Although some attention has been given to the mechanical considerations of applying three-way valves in such service[1], no treatise is known which analyzes the fluid flow characteristics of the circuit for purposes of control-valve application. This analysis presents logical design criteria for assigning pressure drop to three-way control valves.

To arrive at a design basis for the pressure drop to be allowed across three-way valves (thus determining their size also) their flow vs. valve-stem-lift characteristics in service can be compared to those of the well-understood two-way valve, for which a large background of experience is available. It is shown that by the use of certain dimensionless, easily-applied ratios, experience with two-way valves can be extended to the application of three-way valves.

Comparison of Control Methods

The three-way control valve has enjoyed wide use in some fields, such as in water heating systems for large buildings. This by-pass system of control has several advantages over the old method which employs a conventional control valve (Fig. 1), one being its ability to maintain close temperature limits under large heating load changes. Fig. 1 illustrates how time lags and temperature deviations are greatly reduced by eliminating the effect of supply-side capacity with use of a three-way control valve.

The oil refining industry has similar temperature control problems. Until recently, however, they have been done in more-complicated ways that utilize more equipment and have frequently resulted in relatively poor

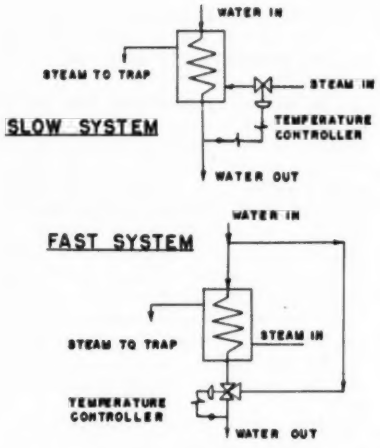

Fig. 1. Hot-water temperature-control methods. Slow-system uses two-way valve; fast system uses three-way valve to eliminate supply-side capacity.

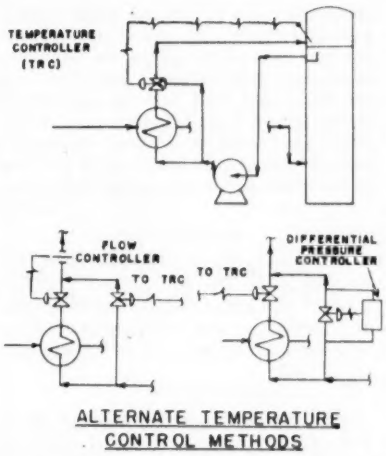

Fig. 2. Methods of fractionator pumparound temperature control. Top, use of three-way valve; bottom, alternate methods using two-way valves.

control. Fig. 2 shows a typical three-way control-valve application together with two alternate arrangements involving conventional control valves. The incentives for using the three-way control-valve system are:

(1) It is less expensive than the alternate arrangements involving two-way control valves.

(2) A consideration in sizing by-pass control valves for the alternate arrangements is the minimum by-pass flow required to be consistent with good control and minimum heat-exchanger size. As a result, the by-pass valves have commonly been sized to handle 20-30 percent of the total circuit flow. This design practice often makes automatic by-pass control impracticable during plant start-up or other below-design capacity operations. The three-way control-valve system, on the other hand, permits automatic by-pass control during these periods.

(3) The three-way valve is inherently safe in that the total open port area is not reduced (conventional three-way valves have a linear and equal lift-area relationship for the two ports). In the alternate by-pass control systems, however, total area and flow can be appreciably reduced if, for example, the shell-side fluid in the heat exchanger is at an abnormally high temperature, or if the dual controllers (flow control and temperature control, or temperature control and differential-pressure control) are not set correctly. Instances have occurred, in circuits having the alternate by-pass methods of control, where the reduction in flow caused safety-valve settings to be exceeded with resultant process upsets.

In using the three-way control valve in place of the alternate arrangements the question arises as to what pressure drop the valve must absorb for good process control.

Flow Characteristics and Sizing of Three-way Valves

It has been shown by J. C. Peters[2] that the flow-lift characteristic of a control valve is important chiefly as it affects the optimum controller adjustments for various process loads that result in different valve-stem positions. Thus, the ideal control valve will have the same optimum controller settings for all stem positions. This condition is met when a given deviation of the measured variable results in a given percent change in the *then-existing* flow rate, regardless of the valve-stem position. This assumes a linear reaction of the process to flow of the control agent, which is reasonably met by the majority of petroleum-refining applications.

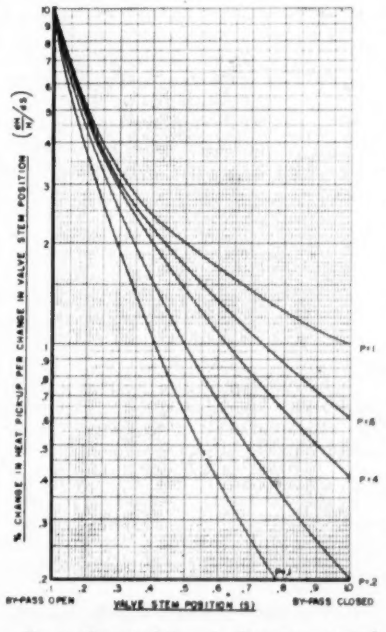

Fig. 3. Characteristic of three-way control valve.

Although Peters' paper referred to the standard (two-way) control valve, it also applies to each port of the three-way control valve. Thus, in the common three-way valve application, illustrated in Fig. 2, the above criterion is satisfied when the percent change in exchanger heat pick-up (dH/H) per unit change in valve-stem position (dS) remains constant regardless of stem position. That is,

$$(dH/H)/dS = \text{constant}$$

Owing to the need for a constant open area, as mentioned, commercially available three-way control valves usually are designed so that the sum of the port areas is always constant—that is, they have linear characteristics. Consequently, the ensuing mathematical analysis is based on linear three-way valve characteristics.

The mathematical equation which describes the three-way linear-control-valve characteristic can be expressed:

$$(dH/H)/dS = [S + S^3 (1 - P)/P]^{-1} \quad (16)$$

where S is the valve-stem position (when S = 0 the by-pass port is fully open), and P is the percentage of the total circuit pressure-drop taken across the exchanger port of the valve when fully open.

Equation 16 is shown graphically in Fig. 3. This figure illustrates that the ideal characteristic is never attained—that is, (dH/H)/dS is not constant. Therefore, the deviation from the ideal must be used as the design basis.

Comparison with Two-way Control Valve

To arrive at a design basis for sizing three-way control valves, it is expedient to compare their characteristics with those of the well understood two-way control valve, for which a large background of experience is available. Peters shows that the characteristic of the two-way equal-percentage valve in

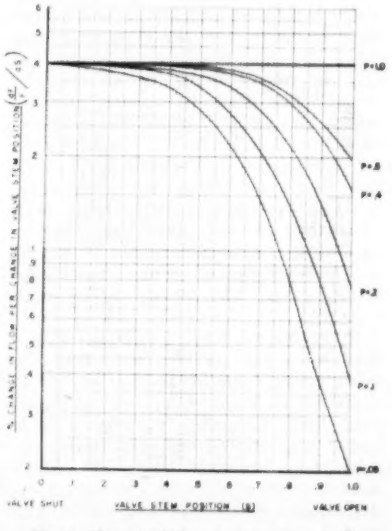

Fig. 4. Characteristic of two-way equal-percentage control valve.

service is nearer to the ideal than the characteristic of a linear control valve in service. Consequently, three-way valve characteristics will be compared with the characteristics of two-way equal-percentage valves.

As shown by Peters, the characteristic of a conventional equal-percentage two-way control valve having a rangeability of 50 can be expressed:

$$(dF/F)/dS = \frac{9780}{\left(\frac{1-P}{P}\right)10^{3.48} + 2500}$$

where P and S are as defined and F is the flow through the valve. This equation is shown graphically in Fig. 4.

Fig. 4 illustrates that the equal-percentage valve attains the ideal characteristic when the valve pressure-drop constitutes the total circuit pressure-drop. Of course, this condition is not possible in practice, and the process designer commonly selects a P value for sizing two-way control valves that is based on experience and consistent with good control and low pumping costs.

The resultant deviation from the ideal characteristic can be expressed as the ratio (R) of the values of (dF/F)/dS at stem positions required for minimum and maximum process loads. The ideal condition is R = 1. R is always greater than 1 when P (the portion of the total circuit pressure-drop that occurs across the valve) is less than 1.

Consequently, a given design basis for sizing two-way equal-percentage valves can be extended to the sizing of three-way linear control valves, such that the departure from the ideal characteristic will be the same for both types of valves. This information is obtained from Figs. 3 and 4.

Example

As a practical example, consider the case when the design basis for sizing two-way equal-percentage valves is such that P = 0.2. This particular value is commonly used in the petroleum industry for the following reasons: (1) Experience has shown that this P value results in satisfactory control for most oil-refining services where the setting of the controller is usually not difficult; (2) larger values of P require that the additional pressure drop be built in the pump—consequently pumping costs increase as P increases; and (3) the equal-percentage valve characteristic at P = 0.2 is somewhat better under service conditions than the linear valve with P = 1.

Referring to Fig. 4, it is calculated that R = 2.8 on the basis that the valve works between 10-percent lift at minimum load and 90-percent at maximum load. Referring to Fig. 3, it is found that for a normal three-way valve-stem position range of 60-100 percent of its travel (40-0 percent open to by-pass), P = 0.35 when R = 2.8. Thus, in this example a three-way valve would be sized on the basis that it takes 35 percent of the total circuit pressure-drop at maximum flow through one of its ports. In practice, three-way valves have been sized on the basis that they take 50 percent of the exchanger pressure-drop (P ≅ 0.35) with good control results. However, other P values can be similarly arrived at for other particular design practices.

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APPENDIX

Derivation of Equation for Characteristics of Three-Way Linear Control Valves

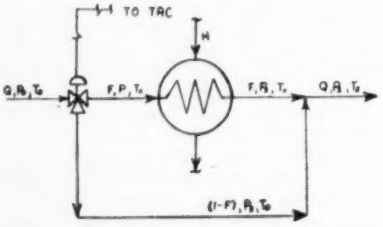


Fig. 5. Three-way-valve by-pass control system for heat exchanger.

Referring to Fig. 5,

- Q = Total flow from pump = 1.
- F = Flow through exchanger.
- (1-F) = Flow through bypass.
- P_o = Pump discharge pressure.
- P_1 = Pressure upstream of exchanger.
- $P_{1\ max.}$ = Pressure upstream of exchanger with bypass closed.
- P_2 = Pressure downstream of exchanger.
- T_o = Temperature of fluid upstream of exchanger.
- T_1 = Temperature of fluid downstream of exchanger.
- T_2 = Controlled temperature.
- H = Heat input to exchanger.
- S = Valve-stem position (S = 1 when F = Q = 1)

The following assumptions are made in deriving the equation that expresses the characteristics of three-way linear control valves:

1. $(T_1 - T_o)$ is constant. In practice, due to approach temperatures normal for counter-current exchangers, this is sufficiently true for even large changes in exchanger flow, F.
2. The fluid is liquid and its specific gravity and specific heat remains constant from T_o to T_1.
3. Total flow from pump is constant.
4. No line losses in terms of heat or pressure drop from points P_o to P_2.

The desired generalized relation is an expression for the percent change in exchanger heat pick-up per change in valve-stem position in terms of valve-stem position and P values. The first phase of the derivation will show that the percent change in heat pick-up is equal to the percent change in exchanger flow. The second phase of the derivation is a generalized expression relating flow through the exchanger with stem position and P values. The third phase of the derivation combines phases I and II to obtain the desired expression.

I. Since $T_1 - T_o$ = constant, by differentiation:

$$dT_1 = dT_o \quad (1)$$

A heat balance yields the following:

$$FT_o + H = FT_1 \quad (2)$$

Differentiating equation (2):

$$F(dT_o) + T_o(dF) + (dH) = F(dT_1) + T_1(dF) \quad (3)$$

Combining (1) and (3):

$$T_o = T_1 - dH/dF \quad (4)$$

Combining (2) and (4):

$$dF/F = dH/H \quad (5)$$

Thus, the percent change in heat pick-up is equal to the percent change in flow through the exchanger.

II. The flow through the exchanger port of a three-way linear valve can be related to the stem position, S, by:

$$F^2 = K_1^2 S^2 (P_o - P_1) \quad (6)$$

The flow through the exchanger can be expressed by:

$$F^2 = K_2^2 (P_1 - P_2) \quad (7)$$

By definition, the percentage of the total resistance drop in the circuit taken across the exchanger port of the three-way valve when fully open is:

$$P = (P_o - P_{1max.})/(P_o - P_2) \quad (8)$$

From equation (6), with by-pass closed Q = F = 1 and S = 1; therefore,

$$1 = K_1^2 (P_o - P_{1\ max.}) \quad (9)$$

Likewise from equation (7) when Q = F = 1 and S = 1,

$$1 = K_2^2 (P_{1\ max.} - P_2) \quad (10)$$

Combining (6), (8), and (9):

$$F^2 = [(P_o - P_1) S^2/(P_o - P_2) P] \quad (11)$$

Combining (7), (8), and (10):

$$F^2 = (P_1 - P_2)/(P_o - P_2)(1 - P) \quad (12)$$

A pressure balance on the system yields:

$$(P_o - P_1) + (P_1 - P_2) = (P_o - P_2) \quad (13)$$

Combining equation (11), (12), and (13):

$$1/F^2 = (P/S^2) + (1 - P) \quad (14)$$

III. Differentiating equation (14);

$$(dF/F)dS = [S + S^3(1 - P)/P]^{-1} \quad (15)$$

Combining equations (5) and (15):

$$(dH/H)/dS = [S + S^3(1 - P)/P]^{-1} \quad (16)$$

Third Prize Winner

Instrumentation in PLANT SERVICE AREAS

Instrumentation is used extensively in all service areas of modern chemical plants. Typical instrumentation is presented for steam generating, plant water supply, compressed air, refrigeration, inventory metering, and effluent treatment. This is the third-prize winner in the ISA New Jersey Section papers contest.

by JAMES F. CONNERAN
Chemical Construction Corp.

IMPORTANT ROLE of instrumentation in the service areas of process plants is often overlooked. Raw material for a plant must be of lowest possible cost and come from a dependable source of supply; it is equally imperative that utilities such as steam, electrical power, inert gas, refrigeration, and effluent-disposal services be economical and reliable. These factors are insured by modern instrumentation.

Steam Generating

The boiler room provides an excellent place to trace the progress of instrumentation. Not many years ago the power engineer relied solely on the drum-pressure gage and drum-level gage glass for manually controlling the boiler. The development of high-capacity boilers with little increase in drum volume became possible by use of automatic water and drum level controls. High combustion efficiency at widely varying load rates is now possible because of modern fuel-air ratio metering and control techniques. CO_2, oxygen, and combustion analyzers now allow rapid transmission of combustion information long before a set of readings can be completed with Orsat apparatus.

Modern combustion-control systems permit burning of 3 or more fuels in a single boiler; thus waste products from process areas can be transformed into useful energy, further lowering production costs. In Fig. 1., a process waste gas "A" from Plant 1 is used in Plant 2, with excess "A" gas burned together with waste gas "B" from plant 2 and a third gas "C" from plant 3. Gases A and B are mixed and the mixed gas is metered as one fuel; metering A and B in individual lines prior to mixing allows a ratio computer to determine the composition of the mixed gas and adjust the reading of the mixed-gas meter accordingly. Natural gas and gas "C" also are metered and the totals are fed into a fuel totalizing system.

Steam pressure adjusts the fuel control valves (initial adjustment), the forced-draft fan damper, and gives initial partial adjustment to the induced-draft fan damper; a furnace pressure controller provides final adjustment to the induced-draft damper to maintain constant furnace pressure. As boiler air flow and fuel flow increases or decreases, a fuel-air proportioning system, which also receives an input signal (of equivalent air required) from the fuel computing system, will make final adjustment of the fuel flow. This is done by increasing or reducing the natural-gas flow, allowing use of as much waste gas as possible; low-pressure switches prevent the pressure in the waste-gas and natural-gas headers from dropping below safe limits.

An oxygen analyzer can be used on such a system as a secondary adjustment of the fuel-air ratio control system, to compensate for the difference in composition of fuels burned.

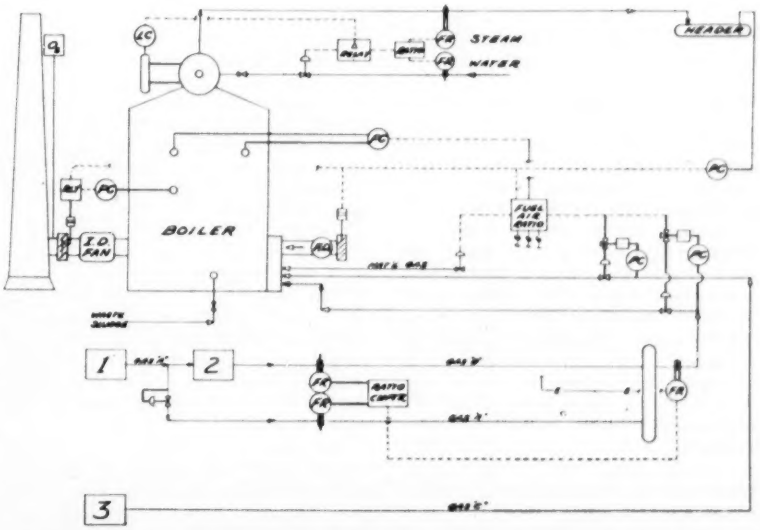


Fig. 1. Steam-generation system with provision for using three waste gases plus natural gas.

A recently designed boiler burns the liquid waste bottoms from a stripping operation, with an air bias setting made possible by choice of flexible control elements. The boiler-water-level control system shown in Fig. 1 is a 3-element system that proportions feed water to steam output, with boiler drum level used as a secondary adjustment of the control system.

Plant Water Supply

When choosing the location of a new plant or expanding an existing plant, the availability of water for process and cooling is an important factor. Unfortunately, even when water is available, it may not be suitable for use in its natural form. Sediment, iron, high or low pH, calcium and magnesium hardness, organic matter, or silica may pose treatment problems.

A typical plant-water treatment system (Fig. 2) illustrates the role of instruments in this type of service. River water supply flows to the pump suction through a screen filter. A differential-pressure switch, with a dip tube on each side of the filter, measures the build-up on the screen. When this build-up reaches a pre-set limit, the switch starts the motor which rotates the screen, opens a valve in the wash-water line, and cleans the screen. These controls allow intermittent action of the screen drive, thereby increasing the life of the equipment.

The screened water flows to the settling basin through a control valve actuated by a level control at the basin. The settled water flow to the coagulation basin is controlled by a similar level-control scheme.

The influent water is metered and integrated, with the integrator actuating a timer to feed dry chemicals (in proportion to the rate of water flow) to a solution tank which empties into the basin. It may be preferable to add liquid chemicals, in which event a proportioning pump or valve could be used in place of the dry feeder.

After a suitable detention time, coagulated water flows over the outlet weir to the pump pit. The sludge which has settled at the bottom of the basin is periodically drawn off. A timer first opens a solenoid valve in a pressure water line for a short period, which allows water back-flow to loosen up the accumulated sludge. This valve is then closed and a valve in the main draw-off line opens to drain off the sludge.

Water to the plant is pumped from the pit by one or two pumps, depending on the pressure in the plant line. Water is supplied to the cooling towers according to make-up needs by level control. The water flowing to the towers is treated with chlorine (to destroy algae) and with acid. The pH instrument also records the pH of return water from the plant, thereby assuring discovery of contamination in leaking heat exchangers.

Coagulated water is also piped to the fire tower storage tank, with a level maintained by an altitude valve. A flow switch in the outlet line from this tower will start the emergency fire pump when flow exceeds the rate used by a single fire hose. A pressure switch is also in the circuit to start the emergency fire pump in event of low water pressure.

The alarms are carried to a central control panel and signal the operator when a dangerous condition exists. Low plant-pressure, low pump-sump-level, high or low pH, or a high cooling-tower sump-level will actuate an alarm.

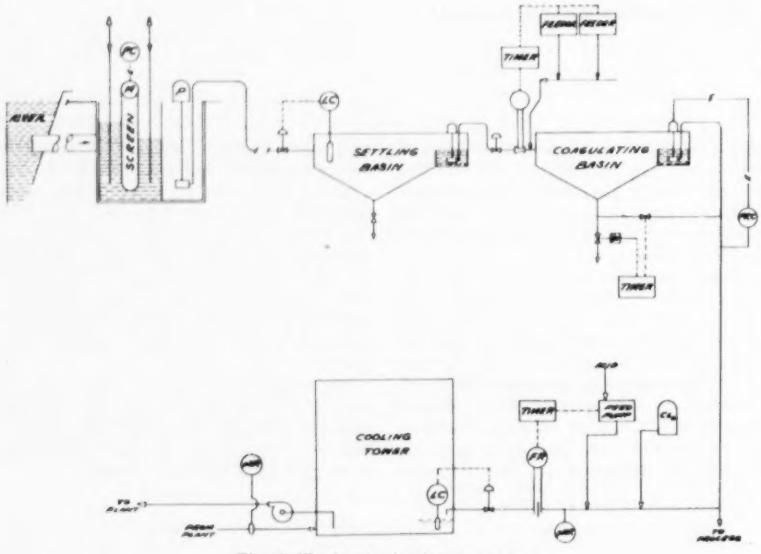


Fig. 2. Plant-water-treatment system.

Compressed Air and Refrigeration

The trend toward large centrifugal compressors has made more difficult the control of these important pieces of machinery. With closely controlled processes using air, it is increasingly more important that the discharge pressure be held within narrow limits. In refrigeration, the suction pressure is controlled. In each type of application, a minimum load control is required to keep the compressor above a "pumping" point on the load curves.

A typical air (or gas) compressor installation is shown in Fig. 3; discharge pressure controls the speed setting of the turbine governor. The flow of air through the suction duct of the compressor is a measure of load, and a flow controller maintains this load at a minimum of 60 percent of design load (safely above the "pumping" point) by venting air from the discharge line through a muffler to atmosphere. Safety controls trip the turbine on low lube-oil-pressure, high discharge-temperature or high turbine-back-pressure. A differential gage across the suction air filter is an indication of filter condition.

In Fig. 4 the refrigerant suction-pressure is controlled by adjusting the turbine-governor speed setting. A pressure controller connected to the first turbine stage (thereby measuring turbine load) opens or closes a "hot gas bypass" valve to maintain a minimum turbine load. Safety controls will trip the turbine on high discharge-pressure or temperature and low lube-oil-pressure. It is good practice to provide an alarm device along with each trip-out device, with the former set slightly above or below the cutout point to warn the operator and possibly avert a plant shutdown.

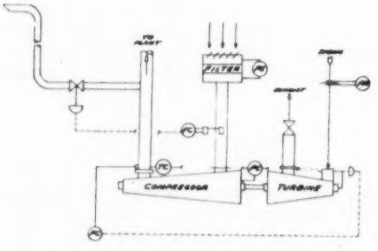


Fig. 3. Air compressor.

Inventory Metering

The cost of utilities must be charged to the product or area in which they are used. Flow meters measure the quantities of steam, water, air, natural gas, and refrigeration. Where large quantities are involved, a recording and integrating flow meter is used; in many applications only the orifice is installed and a portable meter is connected periodically to obtain average figures.

The simplest and least expensive method of meter installation is a dif-

ferential meter mounted near the primary element in the yard piping. Charts can be collected and integrator readings logged daily or weekly. However, this method excludes the operating personnel from having convenient access to the current data. Cooperation in utility conservation efforts is more likely when the people directly concerned can follow the charts which plot their utility usage and costs.

The ideal solution is to install a transmitter, electric or pneumatic, at the primary element; the receiver being located in the central control room with the process instruments. A compromise arrangement is to group all meters measuring utility usage in one production area on a common panel, located in some auxiliary building in the process area. This plan still allows routine checks by the operator, without using costly control-room space or installing long conduit or tube runs.

Preliminary estimates of expected utility usage often go awry, resulting in readings that are "off the chart" if the estimate is low; or in the lower part of the chart if the estimate is high. The use of a differential converter (with an adjustable range of 20 to 200 inches of water) provides a simple way to obtain maximum accuracy and readability of the installation, without change of primary element or range tube. In one plant where utility lines were sized for double capacity of original plant to allow future expansion, this type of converter was used. Flow rates will be doubled at a future date; a recalibration of the transmitter will be sufficient to suit the new conditions.

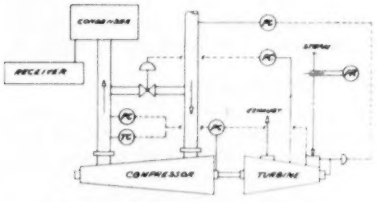


Fig. 4. Refrigeration compressor.

Effluent Treatment

In order to conform with laws recently enacted by the Federal Government and 46 States, industry finds it necessary to invest large sums for equipment to treat its process wastes. Fig. 5 shows a recent installation where cyanide-bearing wastes were treated prior to being released into a river which supplies water for a city located several miles downstream. The treatment is based on alkaline-chlorination of the cyanides to cyanates by addition of approximately 4 parts of chlorine to each part of CN at a controlled pH of about 8.5. Oxidation-potential instruments measure and/or control the proper amount of chlorine in the treated solution.

The plant effluent is first diluted as it enters the five-million-gallon lagoon, where the pH is raised above 8.5 by a pneumatic controller. From the lagoon the waste flows to the treatment tank, and is pumped through injectors where chlorine and additional caustic are added in proper ratios to the effluent flow. A controller measures oxidation-reduction potential and adjusts the quantity of chlorine added. The sample is taken 3 minutes after addition of chlorine, because the reaction then is 95-percent complete, and a second potential measurement is made at the outlet of the 1-hour detention tank. The second instrument automatically adds additional chlorine required, prior to the waste entering the 2-hour detention tank. A final measurement is made for record purposes prior to releasing effluent. A 3-point recorder checks the pH (1) at the plant inlet, (2) after the initial chlorination, and (3) prior to entering the channel which carries it to the river.

The quantity of chlorine fed by each chlorinator is recorded individually. All of the above instruments are mounted on a central control panel. The panel also contains the running lights of each pump and agitator in the system as well as a 30-unit alarm station that sounds a local signal and a remote alarm signal at the main control panel of the power station. Malfunction of a chlorine feeder, low potential (indicating incomplete treatment), low or high pH, or failure of one of service supplies will cause an alarm to be sounded. This system of automatic controls and alarms allows this plant to run unattended except for occasional checks.

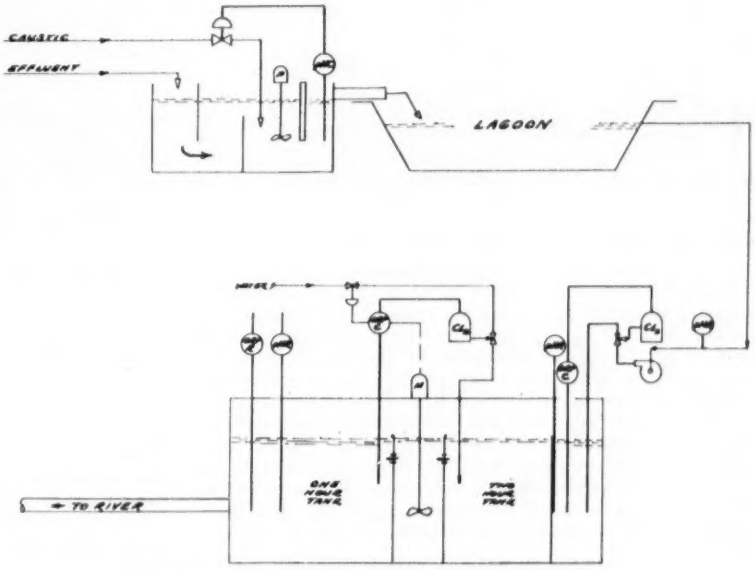


Fig. 5. Effluent-treatment plant for cyanide-bearing wastes.

Instrument Application

The selection of the instruments in the service areas is generally done either by the purchaser's instrument engineers or by the supplier of the major equipment. In the former case, it is wise to obtain the recommendations of the equipment manufacturer and, wherever indicated, submit to them the proposed schemes of control.

However, it is the latter that may provide the most headaches. Specifications for bids should never state "supply necessary instruments." Instead the bidders should be asked to list the items they propose to furnish and/or recommend. These lists should be surveyed by the instrument engineer on the following basis: (1) Are these items adequate but not elaborate, in view of plant policy and the ability of the operating and maintenance personnel? (2) Can these items be fitted into the existing or planned spare-parts program of the plant? (3) Are these items of a special nature which makes it advisable that the vendor purchase them, or can they be specified and bought by the customer? The latter will insure adherence to plant standards and simplify procurement of manufacturer's drawings and instructions.

It is equally important that installation of these items be covered completely by drawings, and all instrument connections indicated on piping or equipment drawings. Arrangement drawings should provide for all panel locations to prevent field interference, as well as routing of instrument piping racks and ducts to eliminate haphazard field installation. Good instrument installation drawings and control schematics are also valuable for maintenance trouble shooting and re-engineering purposes for years to come.

Use of Capillary Tubing for
FLOW MEASUREMENT

Use of viscous flow through capillaries offers a reliable method for measurement of small flows—with the advantage of linear (non-square-root) scales.

by R. F. MAHOOD and R. LITTLEFIELD
E. I. duPont de Nemours & Co.

TESTS were run to determine the reliability and predictability of the Hagan-Poiseuille Law for liquid flow through commercial capillary tubing. The object of this test was twofold—(1) to determine the equation for predicting flow rates in small-bore tubing, and (2) to determine the reliability and practical value of flow measurement with small-bore commercial-grade tubing.

The following conclusions were reached: (1) The linear relationship between pressure drop and flow through a capillary predicted by the Hagan-Poiseuille Law holds true for the data found. (2) The flow rate through a capillary may be predicted with reliability by the Hagan-Poiseuille Law. (3) Ambient and flowing fluid temperatures are critical and must be held constant for a constant flow rate. (4) Under carefully controlled conditions, commercial small-bore tubing would be suitable for metering flows smaller than 300 cc./min. where a differential-type meter is required. (5) For services where accuracy of flow and pressure drop is not critical (such as continuous low flow to a liquid sample system or for pressure letdown systems), capillary tubing is useful.

THEORY

The physical law on which these tests were based is the Hagan-Poiseuille Law, which gives the pressure drop in circular, horizontal pipe for fully developed laminar flow. This equation can be expressed as follows:

$$Q = (3.66)(10^3)(\triangle P)(D^4)/uL$$

where Q is flow rate in gallons per minute, P is pressure drop through tube in psi., D is inside diameter of tube in inches, u is viscosity of flowing fluid in centipoise, and L is length of tube in feet.

Examination of the equation reveals limitations: (1) As there is no correction for vertical head, the tubing must be horizontal. (2) As the equation is derived on the basis of circular-cross-section tubing, use of commercial tubing, which is often out-of-round, will introduce a small error. (3) Flow must be laminar.

The Reynolds Number is used to determine if flow is laminar. It has been found experimentally that if the Reynolds Number is less than 1200 there is a laminar velocity distribution across the pipe. The Reynolds Number is given by

$$N_R = 50.6pQ/uD$$

where p is density of fluid in lb./ft.^{3}, u is viscosity in centipoises, D is inside diameter of tube in inches and Q is flow rate in gal./min. N_R is a dimensionless ratio for any consistent set of units.

In spite of the three limitations, the method offers many possibilities for metering small flows. An important point in this respect is the linear relationship between flow rate and pressure drop. By eliminating the square-root scale, better readability can be obtained for low flows.

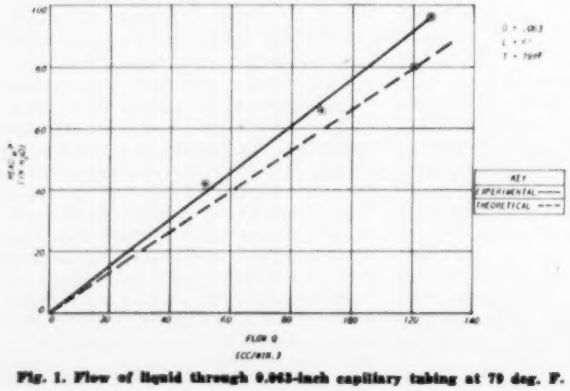


Fig. 1. Flow of liquid through 0.063-inch capillary tubing at 79 deg. F.

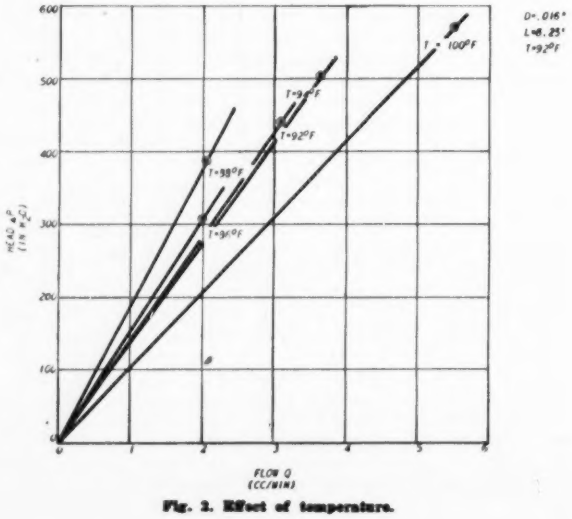


Fig. 2. Effect of temperature.

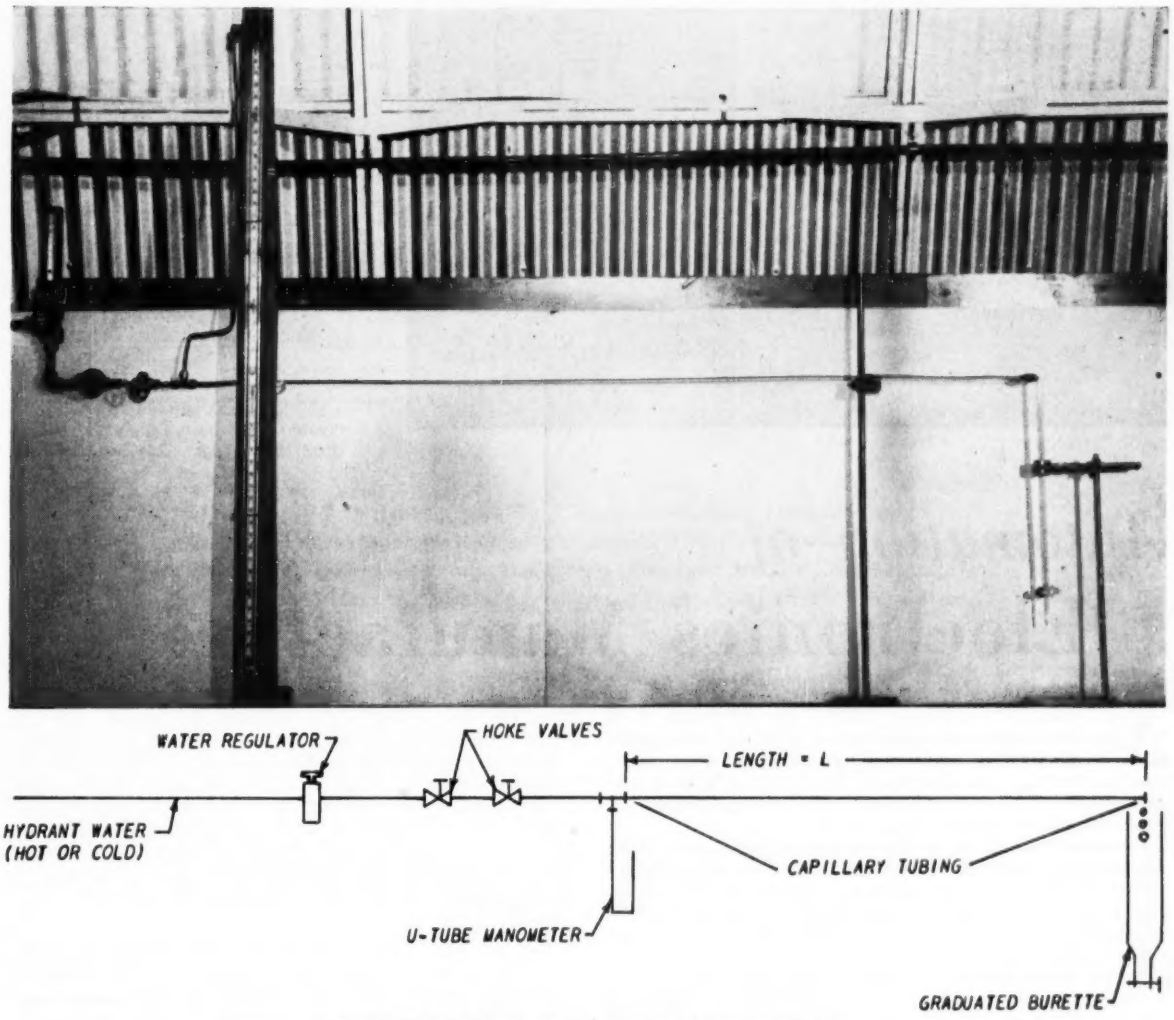


Fig. 3. Photograph and schematic diagram of test equipment.

Test Procedure

The apparatus used in making the tests is shown in Fig. 3. Hydrant water was run through a reducing regulator and discharged through the capillary to atmosphere. The manometer measured the differential pressure. By collecting the discharge over a period of time for various pressure drops it was possible to measure the flow rate through the capillary. The curves shown in Fig. 1 are plotted from the data collected and from the Hagan-Poiseuille Law.

Several errors were introduced. The most significant was the variation in the inside diameter of the commercial capillary tubing. This error is sizable because flow rate varies as the fourth power of the diameter. Another error was introduced owing to a slight slope to the tubing and, as it had been coiled up, there were traces of the coils left. There was no way for accounting for any out-of-roundness of the commercial tubing.

To determine the viscosity effect of the flowing fluid, hot water was used in a separate test. The test equipment was not altered. Data are shown in Fig. 2. These data are incomplete as there was large heat loss through the tubing, which varied with the flow rate. Consequently, for each different pressure drop and subsequent flow rate, there was a different temperature of the flowing fluid.

Results

The head versus flow rate is linear for all tubing sizes as predicted by the Hagan-Poiseuille Law. This allows the use of standard linear scales for flow indicators and recorders.

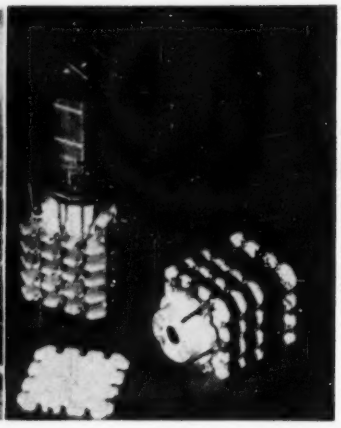
Another important point is the close comparison between the experimental and theoretical curves. This opens the possibility of accurately predicting extremely small flow rates.

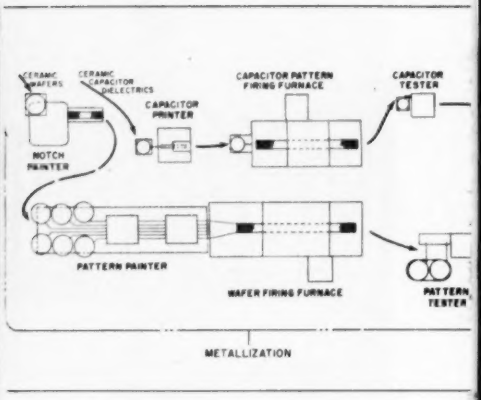
There is danger of plugging if the liquid is not filtered. This, coupled with the fact that each installation must be separately calibrated at each set of conditions, limits the application of small-bore tubings for flow measurement.

The test in which the temperature of the flowing medium was changed shows a large variation in flow. This indicates that the tubes must be calibrated at the actual temperature for which they are to be used. Temperature change from 60 to 33 F. results in a 45-percent error. For slow flow rates there is a large heat loss through the capillary tube; therefore, all installations should be temperature controlled.

In spite of the limitations, this method is one of the few available for metering extremely small flows. It is felt that commercially calibrated meter runs manufactured by several instrument companies would be more suitable for industrial metering of flows above 0.1 gpm. (378 cc./min.).

For applications where high accuracy is not required the Hagan-Poiseuille Law is useful in predicting the flow or pressure drop for various lengths and sizes of tubing. Such an application might be for a continuous sample flow for analysis purposes, or for pressure letdown service. Also, if the tests were run under carefully controlled conditions such apparatus might be used to measure the viscosity of the flowing medium.





"Project Tinkertoy." Left, pilot plant; center, MDE Module; right, mechanized assembly line.

Automation of Electronics Manufacture

AUTOMATIC production line for the manufacture of electronic products, and a novel system of electronics design which makes this possible, have been developed by the National Bureau of Standards. The program, code-named "Project Tinkertoy," was sponsored by the Navy Bureau of Aeronautics.

Starting from raw or semi-processed materials, machines automatically manufacture ceramic materials and adhesive carbon resistors, print conducting circuits, and mount resistors, capacitors, and other miniaturized component parts on standard, uniform steatite wafers. The wafers are stacked like building blocks to form a "module" that performs all of the functions of one or more electronic stages. Automatic inspection machines check physical and electrical characteristics of the parts-mounted wafers at numerous stations along the production line. The completed module is a standardized, interchangeable subassembly.

MDE Design System

The key to the automatic, mechanized production of electronic equipment in "Project Tinkertoy" is the design system developed by the National Bureau of Standards. Called MDE—for Modular Design of Electronics—the system establishes a series of mechanically standardized and uniform modules (or building blocks).

Each module consists of some 4 to 6 thin ceramic wafers, bearing various circuits associated with an electronic stage. A number of individual modules are combined to form a major subassembly.

Mechanized Production of Electronics—MPE

MPE consists of the mechanized production of ceramic wafers, titanate capacitors, and tape resistors, and their automatic mechanical assembly and inspection.

The MPE system is based on the use of bulk or semi-processed materials, and the line produces all the large-quantity parts except for the tubes. The pilot plant is designed for a production goal of 1,000 modules per hour. Joining modules together to form subassemblies may also be accomplished by machines. Time in production is said to be reduced 75 percent.

MPE Steatite Production

Steatite wafers and tube sockets are processed from raw materials and are stamped out at a rate of about 2800 pieces per hour. These parts are cured at 2300 deg. F. in a tunnel kiln. The wafers are then mechanically gaged, and all pieces which do not fit within close tolerances are rejected.

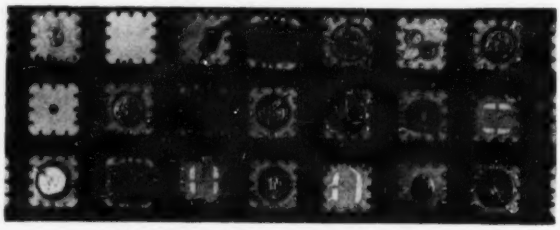
The standard wafer is pressed with twelve peripheral notches (three on a side) and a keying notch on one side. In the final module assembly, riser wires are mechanically soldered into the twelve notches and serve as physical supports for the module and electrical connectors between wafer-mounted circuits. The keying notch is a medium by which individual wafers are automatically oriented.

MPE Capacitor

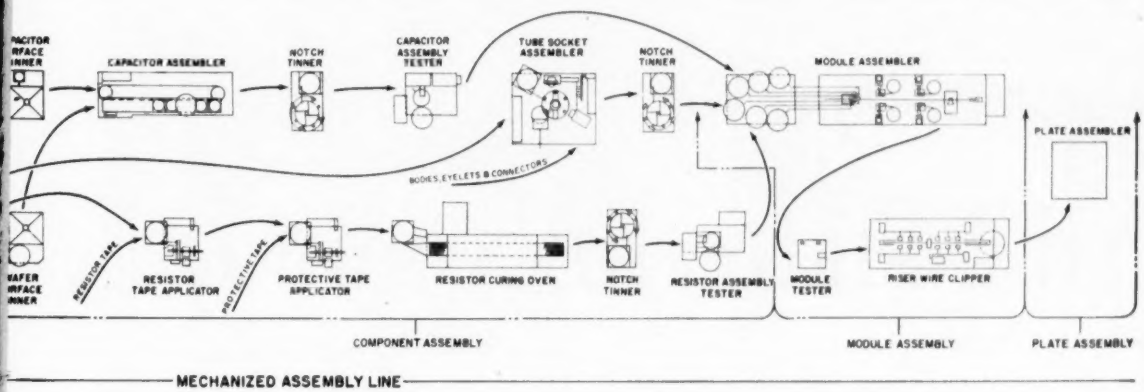
The titanate capacitor body is manufactured in much the same manner as the ceramic wafers. The capacitor is non-porous ceramic composed usually of magnesium, barium, calcium, and strontium titanates of high purity, organic binders, and water. After firing, it is about ½-inch square and 2/100-inch thick. The capacity values may be varied from 7.0 micromicrofarads to 0.01 microfarad by changing the relative proportions of the constituent minerals. Raw material batches weighing about five pounds will produce about 100,000 capacitors.

MPE Tape Resistor

The materials required for the manufacture of tape resistors are a heat-resistant asbestos paper tape (known as Quinterra), polyethylene tape, carbon black or graphite, resin, and a solvent. The resistor formulation (a mixture of the carbon, resin, and solvent) is ground to a fine adhesive powder. The compound is then sprayed on a loop of Quinterra tape, and a protective coating of polyethylene tape is applied. The tape is slit into five or six narrow strips and stored on rolls in a refrigerator. A 75-foot roll of tape will produce over 10,000 resistors. The tape resistors produced have a range from 10 ohms to 10 megohms. They



Varieties of MPE parts-mounted wafers.



Developed by "Project Tinkertoy," modular design of electronics (MDE) and mechanized production of electronics (MPE) offer automatic production techniques to manufacturers, standard unitized subassemblies to circuit designers, and a preview of automation of the future.

will hold their rated resistance within ± 10 percent up to temperatures near 200 deg. F. and are capable of ¼-watt power dissipation at the operating temperature.

MPE Metallizing

Metallizing is the name given to a series of operations in which appropriate sections of the wafer or capacitor body are silver-painted. During these stages, circuits are printed on the wafers, notches are coated, conducting surfaces and leads are applied to capacitors, furnace-curing takes place, and circuits are inspected. Finally, all silvered surfaces received a thin coating of solder. All the operations are mechanized.

MPE Materials Handling

The keying notch pressed into each wafer is initially used during the metallizing operations. The wafers are loaded into vibratory bowl feeders provided with spiral escape channels. A series of four exit ports followed by steps are set into the channels. A small screw is inserted into each exit port that permits only those wafers to pass if the key is aligned with the screw. If the wafer is incorrectly oriented, it is turned 90 degrees as it falls down the channel step following the exit port.

Vibratory bowl feeder orients wafers.

MPE Components Assembly

Tape resistors, titanate capacitors, tube sockets, and other miniaturized parts are mounted on the wafers between the appropriate silvered conducting patterns. Rolls of resistor tape are placed on a machine that automatically cuts the tape into one-half inch lengths, presses the resistors between the printed electrodes on the surface of the wafer, applies pressure, and ejects the completed resistor-mounted wafer.

After the various parts have been mounted on the wafers, the notches on the wafer are tinned with solder. The machine that performs this operation automatically grips each component-mounted wafer and dips one side into flux and solder.

MPE Module Assembly

Uniform wafer-mounted component parts, including wafer-mounted coils, toroids, potentiometers, and crystals are now ready for assembly. The complete assembly of the module is accomplished in a single machine. Six vibratory feeders issue the wafers to a loading device that holds the wafers in an upright position between specially designed jaws. A chain drive carries the jig to a soldering position at which six riser wires are guided into appropriate notches, three on a side. The mechanism brings soldering irons in contact with the unit and bonds the wires to the notches. The unit is turned 90 degrees, and the chain drive carries it to another soldering position.

INDUSTRIAL USE

The MDE and MPE designs and techniques now are available to industry. Companies with experience in the development offer both consulting service and unit modulars. For example, Audio Products Corp., Los Angeles 64, Calif., offers basic circuits in modular form, including addition, amplifiers, cathode followers, clippers, counters, delays, dividers, gates, pulse amplifiers, scale-of-two, timing-pulse generators, etc. Sanders Associates, Inc. of Nashua, N. H., offers experienced consulting on conversion of conventional production techniques to modular design technique, including two complete courses in modular electronics. Modular design kits with 50 basic components are available from Communication Measurements Lab., Inc., 350 Leland Ave., Plainfield, N. J.

A new technique for

TRANSIENT RECORDING

by R. C. BAIRD* and K. W. LAMERS**

Magnetic-tape-recorded data of frequencies to 15,000 cycles can be plotted by X-Y function plotter or recording oscillograph through use of a new technique—vibrating the playback pickup head at constant amplitude and frequency while tape speed is reduced to nearly zero. This new technique permits rapid and inexpensive recording and playback of transient signals—such as compressor horsepower curves—and opens entire new fields for use of oscillographs and function plotters with auxiliary tape recorders.

INSTANTANEOUS PLOTTING of compressor horsepower curves involves data of frequencies from nearly zero cps. to about 275 cps. The horsepower curves, or "cards," are useful for analyzing compressor performance and efficiency [1,2].

Use of an oscilloscope and camera to record the data has disadvantages—(1) processing film in the field is time consuming, (2) photographing the curved CR-tube face limits quantitative accuracy unless the area photographed is small, and (3) reproduction cost is considerable because a single report can contain as many as 50 horsepower "cards" for a single compressor horsepower survey. Therefore, means were sought whereby a function plotter could be used to inexpensively reproduce full-size curves for immediate interpretation.

Basic Problem

Fig. 1 illustrates a typical compressor horsepower curve; cylinder pressure is plotted versus piston position. The entire cycle occurs in 1/5 second for a 300-rpm. compressor. The frequency components of the curve may extend from nearly zero cps. to approximately 275 cps.; reproduction of the higher frequencies is necessary for detecting valve action, acoustical resonance in valves and ports, etc.

It was decided that the data could be recorded on magnetic tape[3]—at a tape speed of about 20 inches per second—and then transferred to full-size plots with an X-Y plotter by playing back the tape at very low speed.

The problem was how to pick up the tape-recorded signal when the tape was moving at nearly zero tape velocity—the time-base reduction necessary to drive the X-Y plotter. Conventional carrier, pulse-spacing, and boundary-displacement recording technique could not provide continuously adjustable read-out. Other methods considered were use of (1) magnetometer[4], (2) variable reluctance, and (3) vibration technique. The vibration technique appeared most practical because it was more sensitive and more linear than the other techniques, and also required no special recording heads.

Vibrating Pickup

The simple expedient of vibrating the pickup head* to extract the signal proved the most practical method for recovering the tape signal while the tape was moving at low speed. The principle of the vibrating head is illustrated in Fig. 4. In order to gain the necessary relative velocity be-

*Patent pending

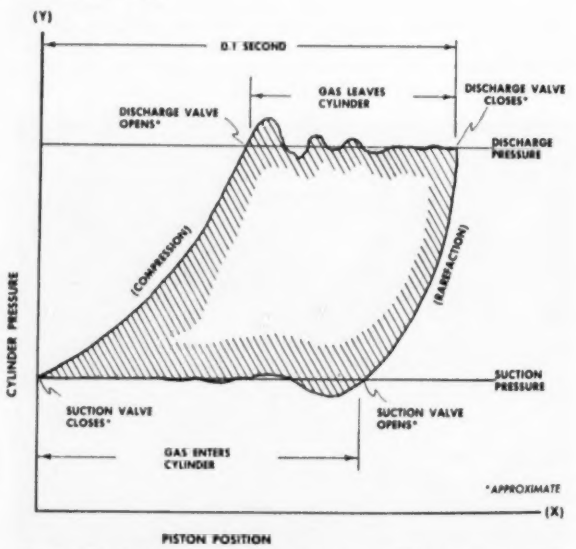


Fig. 1. A typical compressor horsepower curve (300-rpm. compressor).

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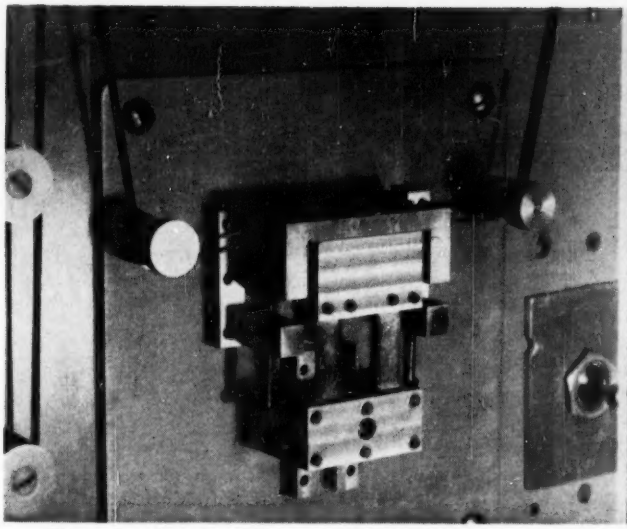

Fig. 2. Two-channel recording and playback head, transverse model, for read-out down to d.c.

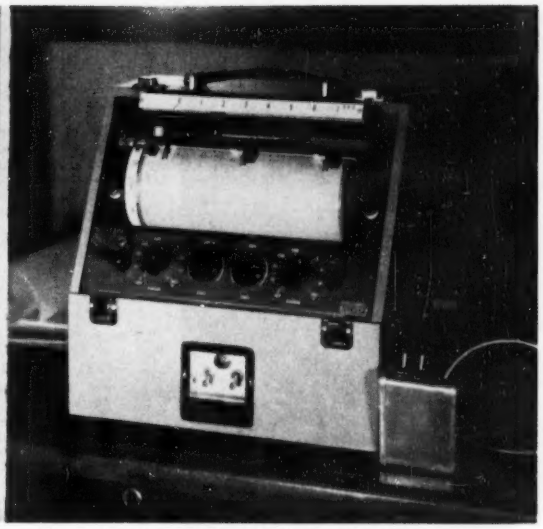

Fig. 3. Function plotter with test x-drive "RC" unit.

tween pickup head and tape for recovering a sufficiently strong signal from a tape moving at extremely low tape speeds, the pickup head is vibrated to cut the relatively stationary lines of force emanating from the tape. The head, *vibrating at a constant frequency and amplitude*, generates an electrical voltage proportional to the magnetic flux density. As the tape is moved past the head it detects the variation in surface flux along the tape—the dynamic-recorded signal. Neither change in read-out rate nor fluctuation in tape speed influences the magnitude of the recovered signal —provided that the tape velocity is low compared to that of the vibrating head.

In order to obtain satisfactory playback down to d.c., transverse recording has to be employed instead of conventional longitudinal recording.** The transverse system produces a surface flux-density proportional not to the differential but to the absolute value of flux internal to the recording medium (the tape)[5]. This mode is not used in commercial recorders because more significance is attached to the higher frequencies necessary for aural reproduction. Transverse recording imposes tracking problems with stationary playback heads, but this is of little consequence when the pickup head is vibrated because of the lateral "scanning" which results.

The pickup head used is a commercial longitudinal-type rotated 90 degrees in order to orient the flux lines in a plane perpendicular to the direction of tape motion. Satisfactory signal amplitudes during playback are obtained with a head vibrating at an amplitude of approximately 0.005 inch (rms). Standard ¼-inch plastic-base recording tape is used.

**The vibrating head method can be applied also to boundary-displacement recordings for recovering signals having frequencies down to zero cps.

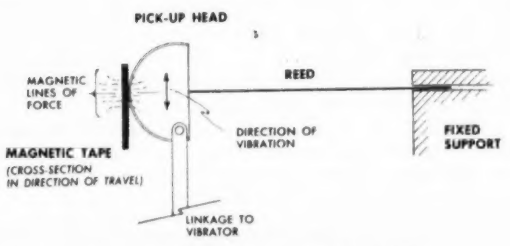

Fig. 4. Basic idea of the vibrating pickup.

The Apparatus

The experimental recording playback-head assembly is illustrated in Fig. 2. As applied to compressor-horsepower measurements, this head assembly provides for two channels at opposite edges of the tape, one for compressor cylinder pressure and the other for piston position. The same head is used for both recording and playback of a given channel. It is vibrated only during playback.

The head is fastened to metal "reeds" and undergoes forced 60-cycle vibration during the playback process. The natural frequency of the reed-head combination is adjusted to be far removed from this 60-cps. frequency. Stimulation is effected through mechanical linkage to a permanent magnet supported to a second metal reed. The permanent magnet vibrates in response to the 60-cycle field from a nearby solenoid. Amplitude is adjusted by varying the solenoid supply voltage. This arrangement is illustrated in Fig. 5, which shows its application to an earlier head assembly designed for playback of longitudinally-impressed signals. Here the plane of vibration is in the direction of tape motion. The vibrator is applied in exactly the same way to the transverse head of Fig. 2.

A special tape guide insures uniform contact between tape and head. This also permits adjustment of contact pressure so that the vibration frequency and amplitude are not influenced by the tape motion.

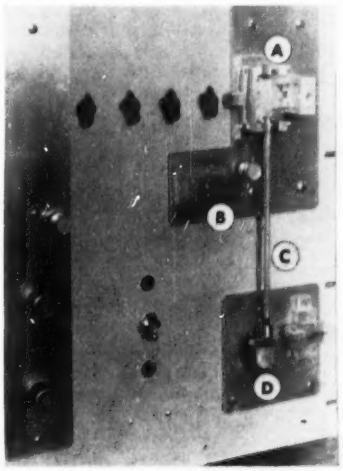

Fig. 5. Longitudinal-type head assembly, showing vibration drive linkage with solenoid core. A, B, C, and D are, respectively, head-assembly, erase head, linkage, and core.

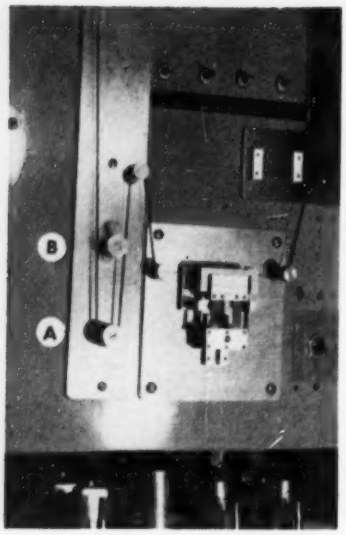

Fig. 6. Transverse-type head-assembly showing portion of tape loop and amplifier equipment. A and B are, respectively, low- and high-speed tape-drive capstans.

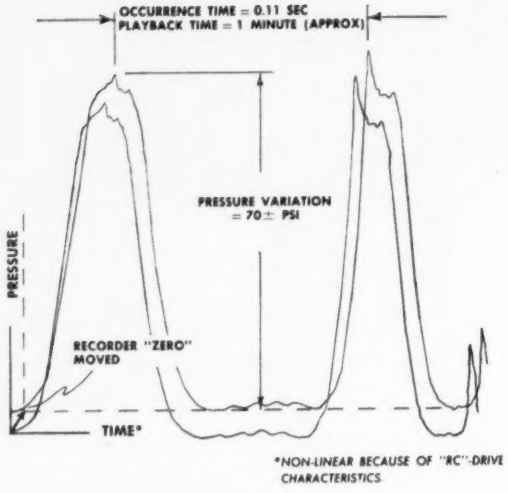

Fig. 8. Single-channel playback-reproducibility of recorded compressor cylinder-pressure signal.

Operation

Fig. 6 shows a portion of the loop of magnetic tape as employed for simultaneous recording of piston-displacement and cylinder-pressure signals for horsepower measurements. As the entire cycle for a 300-rpm. compressor requires only 1/5 second, small-size loops of tape can be used having velocities of 100 inches per second or greater, with assurance that a full cycle will be recorded. High recording velocities give better playback definition of waveform. Multivibrator-controlled switching makes it possible to record a single horsepower cycle on the loop of tape, thus preventing overlapping by later cycles. For the statistical study of horsepower-curve variation from cycle to cycle, a long loop of tape can be used for recording a "burst" of several consecutive cycles without overlapping. Playback tape speed is normally less than 0.04 inch per second, with a recording speed of 20 inches per second, thus giving a playback time reduction of 500 to 1. It is not important that either recording or playback speeds remain exactly constant because the phase relationship of the two signals is physically fixed by the head assembly.

Fig. 3 shows the Moseley "Autograf" electromechanical function plotter used, with a home-made x-drive RC circuit.

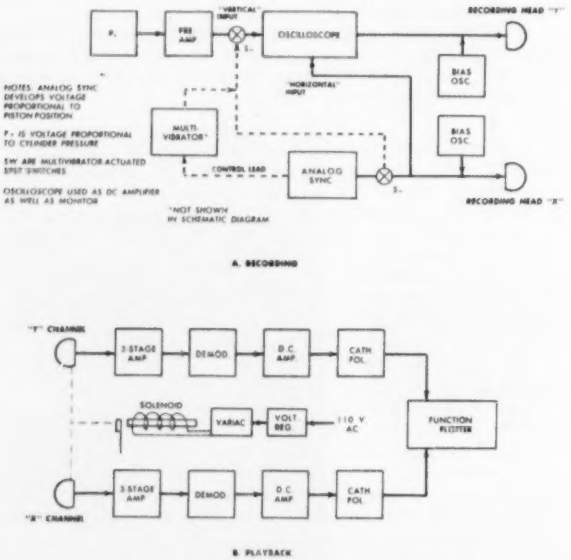

Fig. 7. Block diagrams of recording and playback.

This drive circuit was used for separate testing of simultaneously-recorded signals on their separate channels by providing an independent time-base. Figs. 7a and 7b show the functional arrangements for recording and playback phases. During recording the oscillograph serves both as amplifier and monitor.

Results

Reproducibility of a single channel is illustrated by Fig. 8. Compressor cylinder pressure is the ordinate; the abscissa is "time" as derived from the RC drive circuit. Between plots of the same recorded signal the chart has been shifted on the plotter. Visual comparison of the repeated traces shows only slight differences in the structure of the curve, indicating the high degree of stability achieved.

The vibrating-type playback is both rugged and accurate; it minimizes the necessity for accuracy in tape-speed control; it uses only standard electronic circuits. The read-out rate can be adjusted between extremely wide limits. The complete assembly for two separate channels, involving a single loop of ¼-inch tape for recording transient phenomena, can be housed readily in a small box.

The basic method, by virtue of its flexibility and stability, has application to fields other than that for which it was devised. For example, because of the complete freedom with regard to playback speed, it may be used to supply a time-base shifting operation in electronic computer work. The use of a closed recording loop rotating at high speed, as for the particular project at hand, allows for application to the study of high-speed transient phenomena. With this device it is possible to use direct inking oscillographs having an upper frequency limit of 100 cps. to reproduce high-speed phenomena containing the frequency components upwards of 15,000 cps.—and the low-frequency limit can extend to zero cps.

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Acknowledgement

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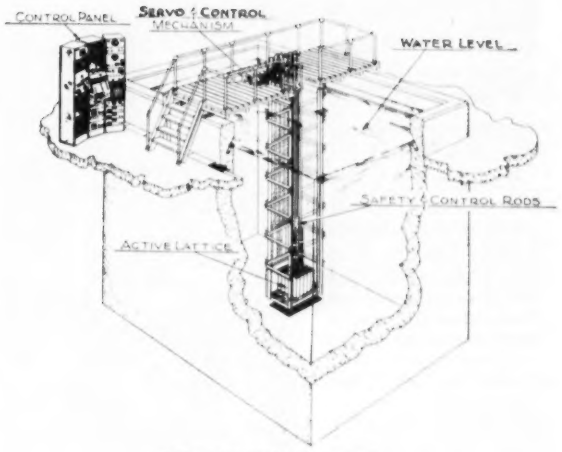
Nuclear Reactors for Industry and Research

COST STUDY

by HENRY J. GOMBERG
University of Michigan



Swimming-pool-type reactor.

Practical factors that must be considered in a cost study include (1) selection of reactor type, (2) power rating, (3) design, construction, and assembly requirements, (4) auxiliary laboratories and equipment, and (5) maintenance shops. This seventh installment presents a recent cost estimate—for a university reactor that is still in the design stage.

COST ESTIMATE for purchase and installation of a nuclear reactor for use at the University of Michigan, in Ann Arbor, Michigan, as part of the laboratory facilities of the Michigan-Phoenix Project, was prepared recently by the author and two of his colleagues. The amount of information on the subject was scant and had to be drawn from many sources. Often it exhibited contradictory aspects. A special difficulty was the fact that few reactors have been built in situations paralleling those of a university campus, at considerable distance from any Atomic Energy Commission installation.

As the university reactor in question is still in the design and negotiation stage, there has been no opportunity to check the accuracy of the proposed budget; it remains unconfirmed. A similar estimate, however, prepared by an independent consulting group for another client, has come so close to that made by the University investigators, that both groups have derived satisfaction from the cross-check. With these facts as background, the author presents the considerations, methods, and results of his study, holding the data subject to revision as experience brings further facts to bear upon them.

Selection of Reactor Type

The first consideration is selection of the reactor type and rating. In making the selection, the following criteria had to be satisfied to justify the investment:

1. Provision of a laboratory for the theoretical and practical considerations that enter into reactor design and operation, including the effect of (a) flux distribution, (b) lattice configuration, (c) cooling, and (d) reflector and absorber effects.

2. Provision of a laboratory for the study of basic principles of reactor operation, control, instrumentation, and construction.

3. Provision of a source of neutrons for experimental purposes. This should include work on solid-state and engineering materials, as well as cross-section measurements, biological effects, induced radioactivity analysis, etc. There is also a special interest in the neutrino problem and the use of an intense source to help resolve it.

4. Production of short-half-life isotopes for fundamental physical and chemical studies as well as for use in radiation tracer and therapy studies.

5. Provision of a laboratory available to industry for long-range research problems.

The choice of design, on the basis of these criteria, was a modified version of the "swimming-pool" reactor described in ORNL 1105, *Nucleonics* (November, 1952), and in Chapter 2 of this series (*Instruments*, Oct., 1953). A 10-kw. reactor of this type has been in use at the Oak Ridge National Laboratory since 1950. However, many modifications were made and, therefore, the cost figures for the ORNL reactor could not be applied directly to the problem at hand.

Modifications Specified

First, the power rating was increased from 100 to 1000 kw. to increase the neutron flux to 10^{13} or 10^{14} neutrons per second per cm.^{2} over significantly large portions of the reactor volume.* These flux levels are the minimum required to produce significant neutron and radiation damage in solid-state systems in practical lengths of time. As one reason for constructing a university reactor is to work in cooperation with industry in the development of the new energy field, it is felt that the reactor built should be capable of simulating anticipated working conditions as closely as possible. To accomplish the power-level change specified, a forced-flow cooling system has been added, the core somewhat enlarged, and the control system generally improved and made more nearly automatic. For example, an automatic pile-period measuring and "scram" circuit has been incorporated.

*Cost estimates for higher power reactors are available in an 88-page booklet "Reports to the U. S. Atomic Energy Commission on Nuclear Power Reactor Terminology," Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price: 25 cents. This booklet contains the declassified versions of reports made to the Atomic Energy Commission by four separate teams of nongovernmental industrial representatives, appraising the prospect for private industrial participation in joint production of electric energy and fissionable material from reactors. The appraisals included examination of both technical and economic problems involved in production from nuclear reactors of electrical energy for industrial and commercial use.

TABLE 4.—ESTIMATED COST OF A NUCLEAR REACTOR CONSTRUCTED AT UNIVERSITY OF MICHIGAN, EXCLUSIVE OF FUEL AND HOUSING

Item		*Cost*
1. *Fuel Elements (exclusive of fuel)*		
31 elements fabricated at $120		$ 3,720
2. *Reactor Core Assembly*		
including grid plate, suspension, control rods, rod drives, etc.		50,000
3. *Concrete Water Tank and Shielding*		
Concrete and reinforcing steel	$ 7,000	
Barytes concrete shield blocks	30,400	
Special barytes block in tank	2,000	
Erection of block shield	5,000	
Tank coating	1,500	
Special excavations and concrete for storage holes	8,000	
Pumphouse, pump foundations, shielding, and roof	3,000	
Gutters and drain for overflow	2,000	
Tank lights installed	1,200	
Special concrete work for neutron ports	3,000	
Ladder, fuel racks, etc.	1,000	
		64,100
4. *Instrumentation for Control*		
Control system and mounting	$58,500	
Special servo-control	4,400	
Period circuit scram	2,000	
PoBe source	2,000	
Fission chamber	2,000	
Air conditioning of instrument room	8,000	
		76,900
5. *Neutron Ports (7) and Auxiliaries*		
Aluminum caisson ports with wall seal	$ 6,000	
Inserts into caissons for experiments	15,000	
Doors and plugs	6,000	
Piping to flood and drain caissons	800	
Beam catcher on cart (2)	8,000	
Lead coffins for moving inserts to storage holes (2)	10,000	
Test tube for rapid passage by neutron beam (rabbit)	4,000	
		49,800
6. *Water System*		
Demineralization system for inlet water, outlet water, and continuous purification	$12,800	
Heat exchange—700 gal/min	13,500	
Pumps and controls	7,800	
Aluminum piping, valves, funnel	1,500	
Special welding	2,500	
Cooling tower, installed	6,000	
		44,100
7. *Crane (installed)*		18,000
8. *Health Physics Instrumentation*		
Gamma monitors—sound alarms waterproof probes (5)	$ 2,500	
air probes (10)	3,000	
Neutron monitor alarm, waterproof	1,500	
Neutron monitor alarm, in air	1,000	
Recorders for monitor systems	4,500	
		12,500
9. *Containers for Underwater Instruments and Experiments*		10,000
10. *Control Bridge across Tank*		2,000
11. *Safety Shield around Top of Tank*		2,000
12. *Consultation Fees on Design*		10,000
13. *Engineering Design and Supervision*		40,000
		$373,120
14. *Contingencies* (10%)		38,000
		$421,120
15. *Overhead for Administration* (8%)		33,400
Total Cost of Reactor Installation		$454,520

TABLE 5.—SUPPLEMENTARY COSTS

Item	*Cost*
1. Beryllium oxide for reflector experiments	$ 20,000
2. Neutron spectrometer	50,000
3. Neutron time-of-flight installation including electronic instrumentation	50,000
4. Special instruments for use with reactor experiments	10,000
5. Remote-control uranyl nitrate solution processing unit (for studying liquid fuels)	8,000
6. Tunnel below reactor for neutrino experiment	15,000
	$153,000
7. Overhead for administration (at 8%)	12,200
8. Total cost of special equipment	$165,200

Second, the tank construction has been substantially altered so that it is not just a concrete-lined hole in the ground, but is more like a large concrete silo standing above the ground. Actually, the "silo" rests on a concrete floor well below ground level, but the external (dry) surface of the concrete tank is accessible on three sides. This arrangement has been effected so that neutron beams may be brought out of the reactor into the laboratory for experiments which cannot be run conveniently under water. The adjustment was dictated also by the need for the maximum utility and flexibility essential for university research.

COST ESTIMATE

The following cost estimate was made on a "swimming-pool" reactor modified as indicated and is, therefore, larger than that for the lower-power sunken unit. It is assumed that the university would act as its own general contractor. A staff consisting of university personnel would be in direct charge of construction supervision. Where possible, fabrication of parts would take place in university shops (as a matter of convenience rather than of economy, because the costs of operation in a university shop differ little from those in private shops). The cost figures cited were obtained after a careful study of design, construction, and assembly requirements. For many items (such as concrete work, sheet-metal fabrication, and heat-exchange systems) the detailed cost studies were based on quoted prices. For other items it was necessary to use reasonable cost estimates based on experience and on many consultations with AEC reactor engineers.

In the original study, the cost of auxiliary laboratories for hot chemistry or for any of the work associated with a reactor laboratory was not included. The reactor installation is to be part of the main Phoenix Project Laboratories, which provide hot caves with remote control manipulators, hot chemistry laboratories, and a hot machine shop as well as extensive facilities for handling experimental animals and microorganisms as required for research in biological effects of radiation. Of course, to justify fully a research reactor installation in a university, adequate auxiliary laboratories for reactor-connected research must be provided. The question of how many of these auxiliaries should be charged against the reactor depends, however, on the individual situation.

As a final note, it should be remembered that fissionable material cannot be bought; it can be obtained only

on a loan basis from the Atomic Energy Commission. Therefore, the Commission must be a participant in any installation, supplying, as a minimum, the fuel. The exact value of this material is classified, but it can be stated in general that for any reactor the fuel represents a large investment.

To complete the reactor installation, provision must be made for a building, experimental instrumentation, laboratories, and experimental maintenance shops. The costs again vary with the university situation, with the location of the reactor in relation to other facilities, and with other factors involved.

If the simple "swimming pool" arrangement is to be used without neutron beam ports and auxiliaries, a plain shed may be installed over the pool, the top surface of which is at ground level. The shed should, however, have a height of two storys to accommodate the overhead handling equipment. The simplest frame—about 20-feet high, 40-feet long, and 50-feet wide—will cost (at $1.50 a cubic foot) $60,000.00. If the building is enlarged to include laboratories, or if the excavation is extended so that the "silo" type of structure may be used, the cost will be approximately double the amount quoted. Finally, if a university type of exterior is planned and an interior with no frills but with provision for neutron beam work, the estimate for the building is approximately $250,000.

Table 5 gives a list of items of laboratory equipment, including a few experimental instruments. (Some of these items tabulated are necessary for reactor research; some are not.) The author includes the table because it provides the order of magnitude commonly encountered in work in the nuclear field.

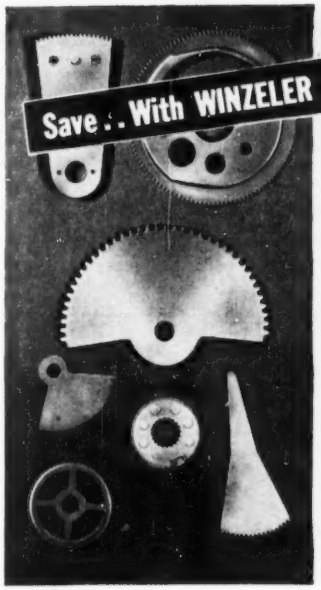
ANNOUNCEMENT

The entire series "Nuclear Reactors for Industry and Research" will be available in book form at the conclusion of the series. The final subject to be discussed will be legal aspects for installation and operation of nuclear reactors, by H. T. Van Mell, Attorney at Law.

Finally, in the matter of auxiliary laboratories, there is no true limit or cut-off point. In general, university laboratory costs are running currently at approximately $2.25 a cubic foot. Caves such as those used at the Argonne National Laboratory for hot metallurgy start at approximately $60,000. Remote-control manipulators for use in these caves cost about $12,500. These costs should be added over and above the $2.25 a cubic foot figured for the laboratory as a whole.

A study of these various cost estimates will show that there is much to be gained if an existing building can be adapted to housing the reactor, particularly if it can house laboratory facilities as well. With such a building the total estimate of installation will drop appreciably.

There has been much unrealistic talk about "cheap" reactors. The reactor core itself may be relatively inexpensive, but if a research laboratory in which an integrated investigative program of the type which should be expected in a university or large industrial plant is to be established, the over-all cost must include all the factors for the complete program. This should not, however, keep universities and industries from considering the installation of a small research nuclear reactor. Atomic fission is now a vastly significant, attention-demanding fact in the present-day world, and universities and plants, if they are to remain abreast of modern scientific and technological development, must adjust their strides to the new rhythms and must find means to meet the new needs.



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STEAM TRAPPING

Efficient steam trapping is essential for economic use of steam. Factors of importance to the instrument man include where and how to use traps, selection of proper trap type, steam tracing, and sizing the trap.

by KENNETH G. OLIVER
Sarco Company

INSTRUMENT MEN in modern engineering firms generally provide the steam-trapping arrangements. Why use steam traps? Answered briefly, a steam trap enables the plant engineer to get the most practical use from each pound of steam. All too frequently the first cost, cost of installation, and maintenance costs are given more emphasis than the value of steam the trap may save—or waste.

The following general installation recommendations reveal how and where traps should be used:

1. Condensate flowing in a steam main must be stopped in pockets before it can be efficiently trapped out.
2. Condensate in a steam main must not be expected to go up a riser. It should be removed at the foot of all risers, otherwise water hammer of the worst type can result.
3. Condensate from high- and low-pressure systems should be discharged to separate returns.
4. All traps, except thermostatic style, should be installed as close to the equipment being drained as possible.
5. All traps should be protected by strainers, readily accessible for cleaning.
6. Do not insulate the inlet line to the trap.
7. Condensate should be removed from the lowest point in the system wherever possible. This may call for an internal syphon pipe in some instances.
8. Process equipment should be individually trapped, to permit the operator to get the best use from each piece of equipment.
9. In lifting condensate, the trap should preferably be at the foot of the lift. If necessary to place it at the top, use lift fittings on the riser. A check valve should be at the low point in either case.

April Meeting: Thursday, the 15th, Rio Hondo Country Club, Downey, Calif.

Feature: Mr. Donald Gayton, Fischer & Porter Co., will present a paper on "Area-type Flow Meters."

Selecting the Proper Trap

Control valves in a plant usually are chosen with great care, no one valve being considered as a "universal" valve. The same consideration should be given to steam traps; there is no "universal" steam trap.

Each application in a plant has its own characteristics, and the trap should fit individual needs. The table presents the characteristics of the various types of traps and may assist the instrument man to choose the steam trap most nearly meeting the requirements.

Trap Types

Inverted-bucket Trap (Fig. 1)

This trap works best on equipment having a fairly steady load, close to its maximum capacity, such as dripping medium and high-pressure mains. It is rugged, cheap, and simple, but requires large numbers of spare parts. It cannot differentiate between air and steam and, therefore, becomes airbound easily. The bimetallic vent available with most models is good for initial clearing of air only; once the trap is at operating temperature the vent remains closed and is of no value. When closed, the trap will not open again until the steam or air in the bucket has been dissipated, regardless of conditions ahead of it. Some resistance to freezing may be obtained by insulating it, but at the expense of capacity and sensitivity. This trap is not recommended for equipment under close temperature control, its few good points being overshadowed by its bad points. Whether

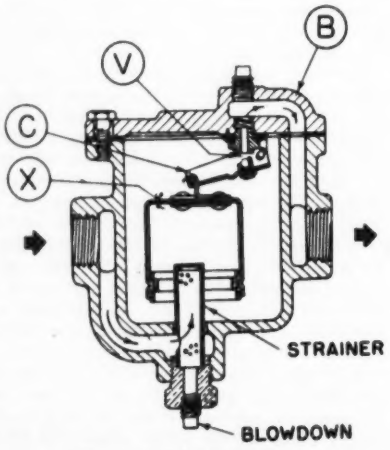


Fig. 1. Inverted-bucket trap.

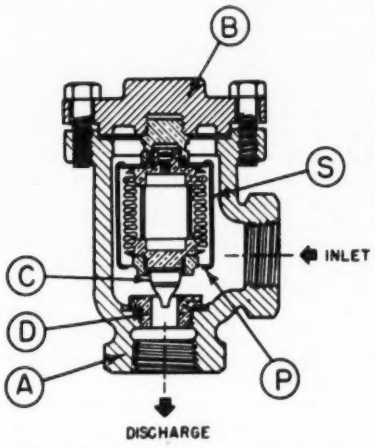


Fig. 2. Balanced-pressure thermostatic trap.

inverted or open top, it is still a bucket trap.

Balanced-pressure Thermostatic Trap (Figs. 2 and 3)

This trap is not well understood, so a brief discussion of its operation is appropriate. Referring to Fig. 3, Curve A is the saturation curve for steam or water. By mixing a suitable volatile liquid with water, Curve B results, whose vaporizing temperature throughout its length is a certain amount below that of water at the same pressure. This is the element filling; the temperature difference will vary with the design. Line p represents condensate flowing through the trap on a discharge cycle, its temperature increasing to the right. The element filling absorbs heat. At point 1 the filling reaches its vaporization point and produces pressure $\triangle p_1$ over the condensate pressure, forcing the plunger down onto the seat. The condensate in the body cools along p to the left until point 2 is reached, where the filling has condensed sufficient to produce $\triangle p_2$ outside the element, causing it to contract and open the trap. The greater the temperature difference between A and B, the more operating power is available, and the higher is the capacity. This element oscillates about its free length—under slight compression when the trap is open, and under slight tension when it is closed, resulting in little bellows strain. If the element filling is water only, curve B will coincide with curve A, and the internal pressure cannot exceed the external condensate pressure. At the closing point, the major part of the power must come from the bellows itself, requiring larger, heavier elements, always operating under compression.

Use this trap on process heating equipment where large condensate and air-venting capacity is required. Being intermittent in operation, low discharge rates will not harm the seat. Good resistance to water hammer may be obtained with a completely filled element, at the expense of sensitivity. Its tendency to waterlog the equipment while the condensate cools may be easily canceled with about 3 feet of collecting leg ahead of it. This trap is one of the best to consider when standardization is under way.

Things to check on thermostatic traps: (1) Size of the orifice, D. (2) Shape of the head, C—parabolic head gives the largest opening area for a given vertical travel. (3) Number of bellows convolutions, S—the greater the number, the less strain on them and the longer they will last. (4) Bellows material—phosphor bronze is the best for general use; monel and stainless steel are more resistant to corrosion but subject to fatigue.

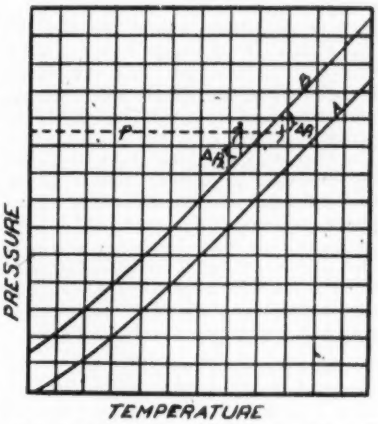


Fig. 3. Saturation curves of water (A) and mixture of volatile liquid with water (B).

Thermal-expansion Trap (Fig. 4)

This one comes in two general designs, the one shown being the latest and shortest design. The valve head, V, is carried on a plunger, which is attached by a flexible bellows, T, to a floating piston. The piston and bellows are surrounded with mineral oil, which absorbs heat from the condensate flowing past the element, E, expands, and closes the valve. The closing tempera-

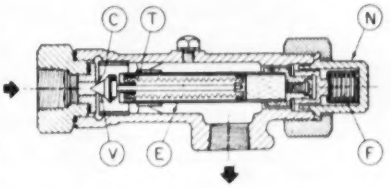


Fig. 4. Thermal-expansion trap.

STEAM TRAP SELECTION CHART

Characteristic	*Inverted-bucket Trap*	*Thermostatic Balanced-pressure Trap*	*Thermal-expansion Trap*	*Thermodynamic Trap*	*Float and Thermostatic Trap*
Pressure Range	0-900#	Vac.-300#	0-500#	2-2500#	Vac.-250#
Relative Capacity	Small	Very Large	Medium	Medium	Single-seated: Medium; Double-ported: very large
Discharge Temperature	Close to steam temperature	3-30° below steam temperature	Adjustable below 212°	Varies with condensate load	Close to steam temperature
Air Discharge Ability	Poor; fair with vent	Excellent	Good	Good	Excellent
Sensitivity to Rapid Load Changes	Poor	Good	Fair	Fair	Excellent
Use on Superheated Steam	Low superheats only	Poor, unless special elements used	Good	Excellent	Poor
Resistance to Freezing	Poor	Excellent	Excellent	Poor	Poor
Resistance to Corrosion	Good	Fair to good, depending on element material	Fair	Excellent	Fair
Resistance to Water Hammer	Good	Poor to fair, depending on filling	Excellent	Excellent	Poor
Syphoning Ability	Poor	Fair	Fair	Good	Excellent

ture is adjustable below 212 deg. F. Due to the low discharge temperatures, this trap is best used on equipment being drained to waste, permitting maximum heat removal from the condensate. It sees good use as automatic drains on equipment and mains in freezing climates, remaining mostly closed under normal service, opening up completely when steam is shut off. A long collecting leg may be required ahead of it under some applications. One variation is used for approximate temperature control by forcing a waterlogged coil and regulating the heat transfer.

Thermodynamic Trap (Fig. 5)

Disk D forms a valve which seats on inlet tube J and also on outer rim K. It is free to rise and fall in chamber S. When seated, this disk closes inlet tube J and also seals chamber S from the discharge. Incoming condensate or air under pressure raises the disk and flows radially across the underside to outlet chamber Y. When steam enters, its velocity across the disk is much greater, and it quickly flows around the edge of the disk and builds up a pressure in chamber S. This pressure, acting on an area larger than exists under the disk, causes it to seat, closing the inlet tube, and sealing steam above the disk. As this trapped steam condenses or leaks through port P, the inlet pressure again lifts the disk and starts another cycle; therefore, the action is pulsating under low to normal loads, becoming continuous under higher loads. It discharges air readily and can be used as an air vent on higher pressures. The model shown has no sharp-edged seats subject to sticking and pounding. However, all models of this trap should be protected by a fine mesh screen ahead of it, about 60 mesh. It is best used on superheated steam and above 300 psi.; below that pressure other traps are usually more suitable. It finds good use in power plants, for marine use, under extremely corrosive condensate conditions, or where water hammer is a problem.

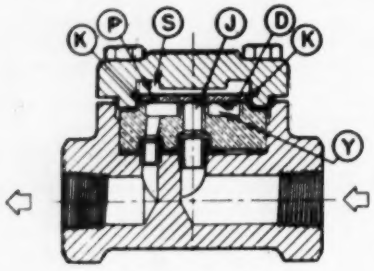


Fig. 5. Thermodynamic trap.

Float and Thermostatic Trap (Fig. 6)

The trap shown in Fig. 6 is an example of a true float and thermostatic trap, having a closed float (F), a continuous modulating discharge, and a balanced-pressure thermostatic air-vent (E). When properly placed so as to get a free drainage, the float positions the valve head, H, to discharge the condensate as fast as it reaches the trap. Thus it keeps the condensing surface dry and gives maximum use of heat-transfer area. The air vent prevents the trap from getting air-bound, by-passing the air from the top of the trap, through a separate orifice (B), into the discharge line.

Use this trap on all high-speed condensing equipment where the load is subject to rapid changes, or where close temperature control is being used. It works with the control, and not independent of it. Low-pressure mains and vacuum-return systems use this trap to good advantage. It is available in double-ported type for high capacities. It may be made fairly freeze-proof by adding a thermostatic drain on the drain plug in the body.

Things to check: (1) Orifice position, H—should be below the water level in the trap to prevent steam leakage; should open against steam pressure. (2) Size and weight—large, heavy traps not necessary; one shown is light enough to be supported by the piping only. (3) Linkage—should be as simple as possible to facilitate maintenance. (4) Air Vent, E—should be balanced-pressure type, not a pet-cock or bi-metallic type.

Trapping of Temperature-Controlled Equipment

A good part of the steam generated in the modern plant is condensed in heat-transfer equipment, some of which may be under close temperature control. Consider such an apparatus in which the load is variable and changes rapidly, and where the steam is controlled by a modulating valve with a sensitive controller. The constants are the temperature of the controlled medium, the line steam pressure, the usable heat-transfer area, and the return line pressure. Changes in flow rates of the controlled medium, whether large or minute, must be met by change in heat-transfer rate, which is accomplished by altering the steam temperature. The product temperature is actually being controlled by the control valve regulating the steam pressure in the heating coil. Further, the steam pressure drop through the heating coil should vary with the load. To permit the sensitive controller and valve to work properly, the condensate must be drained rapidly and smoothly, the heating coil should be isolated from the return line pressure to permit minute changes in steam pressure, and the trap should be sensitive enough to work with the control valve and not independent of it. These specifications call for a float and thermostatic trap, the only one which is instantly responsive to changed pressure and load conditions.

Importance of Removing Air

Air or non-condensable gas in steam spaces has four effects: (1) Lowers the temperature of the air and steam mixture, thus reducing heat transfer. (2) Insulates the heat-transfer surfaces effectively. (3) Causes corrosion in return lines. (4) Retards passage of steam and condensate.

Therefore, it is important to get rid of air as fast as possible. The only way of doing this properly is to study each piece of steam-using equipment to find the pockets in which air can collect. Find the point in the steam space where the steam will flow last. Place an automatic air vent of the balanced- pressure thermostatic type at that point, and the full amount of heat transfer surface will then be in use.

Steam Tracing Service

Steam tracing service falls into two general classes—(1) large lines and tanks and (2) instruments and gages. The condensate is often wasted at the trapping point.

On large mains, sprawled over a large area, it isn't practical to drain the lines manually to prevent freezing upon shut-down. A thermostatic trap will serve double purpose here, draining the line dry when shut down. The balanced-pressure type is best if the condensate is being returned and the product line temperature is greater than 212 deg. Otherwise, the thermal-expansion type is best to use.

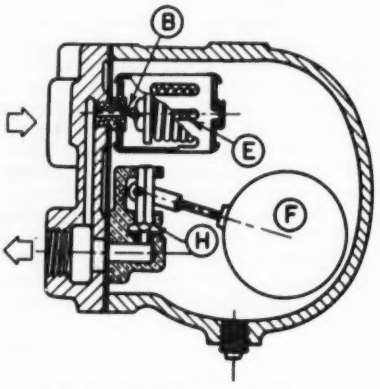


Fig. 6. Float and thermostatic trap.

In tanks, a submerged coil is employed most often. The thermal-expansion type will not only drain the coil but may also be made to regulate the temperature of the tank contents.

Instruments and gages are most often traced by means of small pipes and copper coils, not always trapped. If specifications and line size require trapping, the most inexpensive miniature trap of the thermostatic type will usually suffice. Otherwise, a needle valve will be sufficient. If the climate is temperate, place the valve on the inlet to the tracer; if climate is severe, the valve should be on the discharge of the tracer.

Sizing Traps

The key to comparing capacity tables is the size of the orifice and the method by which the manufacturer has arrived at his capacities. Any engineer can cal-

culate (by handbooks) the expected cold-water discharge from a sharp-edged orifice, but the performance of that orifice in a trap on a steam condenser handling hot condensate is an entirely different matter. No two traps with the same size orifice and the same operating principle will vary greatly in their true capacity. If the tables show otherwise, it is a good idea to read the fine print under the tables, and mistrust the one with the highest ratings; no trap manufacturer in today's competitive market will deliberately under-rate his traps; the tendency is to over-rate them. The most trustworthy tables are the ones derived from actually setting the trap on a steam condenser and running hot tests on it. The condensate load is increased until the trap just handles it without waterlogging the condenser and while discharging continuously. This is taken as the maximum capacity under those specific pressure conditions, and is the capacity usually stated in the reliable tables.

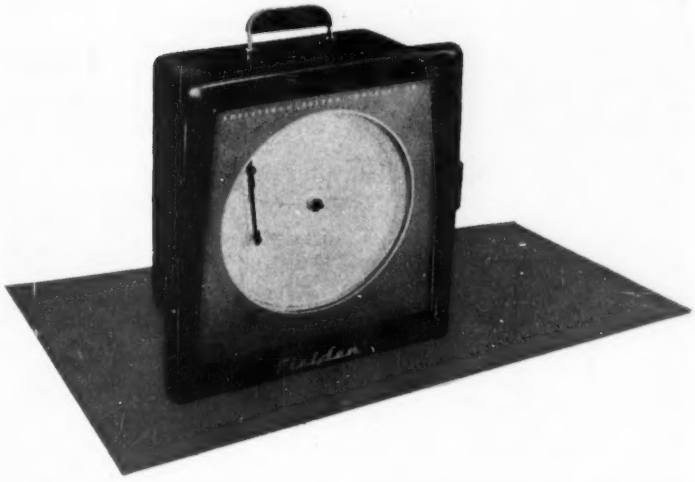
In order to compensate for various unknowns, safety factors are used which may vary between 2 and 4 to 1. If a selection table recommends consistently higher values, this is probably done to compensate for over-rated capacities. The starting-up load under reduced pressures is taken care of in this capacity factor. Generally speaking, applications calling for the continuous modulating type of trap will seldom require a capacity factor of over 2 to 1. Cycling traps on intermittent equipment will call for factors of 2 or 3 to 1, occasionally going as high as 4 to 1. Customer specifications or individual experiences may over-ride these recommendations.

Following are several hints on sizing traps, all of which will tend to reduce the required safety factor: (1) The "net effective pressure" referred to in capacity tables is simply the pressure drop across the orifice. (2) On process equipment, remember to allow for the pressure drop through the inlet valves and the heating coil, in arriving at the trap inlet pressure. (3) On main drips, choose a trap capacity of 1 pound per hour for each square foot of outside main area, ignoring the insulation. This includes all safety factors. In freezing climates or if the main is uninsulated, multiply this by 1½ to 2 times, depending on conditions. (4) To prevent water hammer in a return riser, do not expect a trap to raise the condensate more than 1 foot for each pound of pressure ahead of the orifice.

Conclusion

The final criterion is best arrived at by asking yourself these questions: Is the client getting the most practical use of his steam and his equipment? Is the arrangement as simple as practical? Have all factors been properly considered? If your answer is "yes" throughout, then your specification is finished.

accurate instrumentation need not be costly



here's proof . . . Accurate to ± 1% of full scale, this Fielden Tektolog Electronic Recorder has a sensitivity of ± 0.1% and reproducibility of ± 0.5%. Yet it sells at a price substantially below that of servo-operated potentiometer-type recorders!

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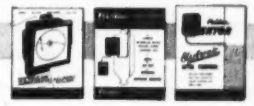
CONTROLS COMPANY



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2920 N. 4th St., Dept. A, Philadelphia 33, Pa.

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☐ Telstor Electronic Level Indicator ☐ Tektor Electronic Level Control

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*Title*_____

*Company*_____

*Address*_____ *City*_____ *State*_____

Fielden TEKTOR Electronic Level Control

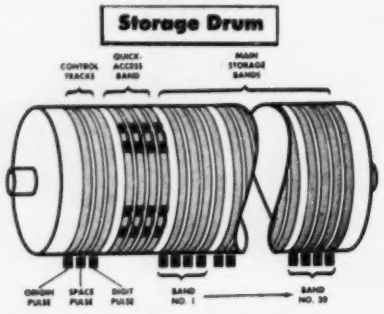
Fielden TELSTOR Electronic Level Indicator

For more information circle **124** on inquiry card.

Briefs . . .

Quick-access Memory

Computational speed of the 30-203 Digital Computer is high for a computer of its magnitude due to the unique "quick-access" section of the magnetic memory, which reduces the average access time for an entire block of 80 words to only 0.85 millisecond. The 80-word section may be temporarily filled by commands transferred individually



or in groups of 20 words prior to the moment they are needed. They are then available in the 0.85-millisecond period rather than in the average of 8.5 milliseconds which would be necessary if they had to be obtained from the main memory of 4000 words. (*From new Bulletin CEC-3100, Consolidated Eng. Corp., Pasadena 15, Calif.*)

For this literature circle **609** on inquiry card.

Combustion Control

Changes of oil characteristics, temperature and pressure, draft, number of boilers . . . and other variables will upset the fuel-air ratio established by the original settings and result in either smoke or excessive chimney heat waste . . . Fluctuations in "haze density" cause variations in photo-electric-cell current, which controls a motor controlling air to furnace. The correct fuel-air ratio for proper haze density is thus maintained. (*From new 4-page Bulletin SA 11-50 of Standard Instrument Corp., 350 Fifth Ave., N. Y., N. Y.*)

For this literature circle **610** on inquiry card.

Table of Transforms

In network design and analysis it is useful to have a graphic representation of common time functions and their corresponding transforms (frequency spectra). No convenient table appears in the literature. . . . Such a table has been prepared. . . . Slopes are indicated; unity slope is equal to 6 db. per octave. (*From Vol. 5, No. 3-4 issue of "hp Journal," Hewlett Packard Co., 395 Page Mill Rd., Palo Alto, Calif.*)

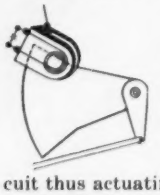
For this literature circle **611** on inquiry card.

Tape Resistor

Resistors in tape form are ready for instant use. Connector at each end comes covered with thermosetting adhesive. A momentary pressure with a hot iron and the resistor is permanently connected into any printed circuit. Size: ½-inch long, ⅛-inch wide, 1/100-inch thick. Power rating: ¼ watt. Resistance 100 ohms to 10 megohms. (*From new brochure of Sanders Associates, 137 Canal St., Nashua, N. H.*)

For this literature circle **612** on inquiry card.

"Electr-O-Vane" Controller



The *Electr-O-Vane* unit provides a sensitive way of obtaining corrective electric control of a motorized valve, solenoid valve, or power contactor. It includes an electronic snap-acting load relay, a pair of oscillator coils, a vacuum tube and a metal vane connected to the recording pen. As the vane moves between the coils, it detunes the circuit thus actuating the relay. SPST or SPDT contact action can be obtained with one control unit. The difference in vane position between on and off can be 0.002 inch. (*From new 46-page Catalog 6709, Minneapolis-Honeywell, Ind. Div., Phila. 44, Pa.*)

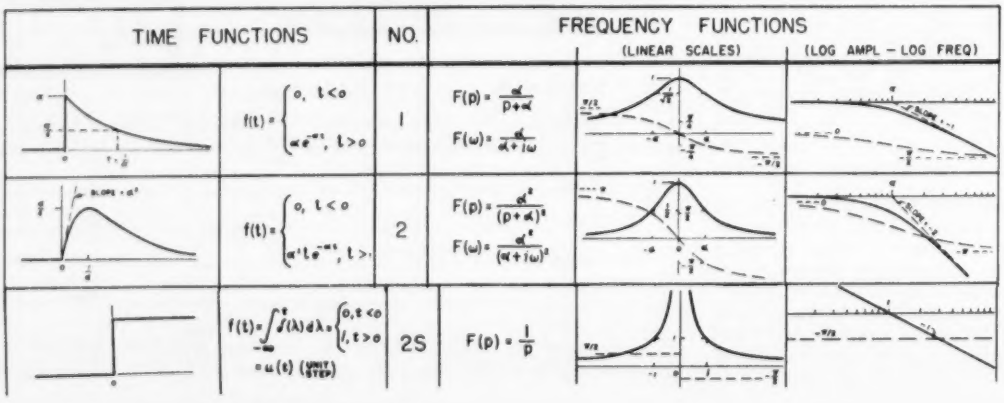
For this literature circle **613** on inquiry card.

Analytical Techniques

X-ray Diffraction: When X-rays are directed into a sample material, a series of secondary beams of radiation is reflected from the specimen upon a sensitized film—a series of concentric lines appear on the film.

These lines are the result of reflections from the atomic planes of the specimen and, as no two materials present the same film pattern, the method can be used for positive identification, detection of changes, or impurities in even minute specimens. Film analysis requires time and care for processing and interpretation and is an excellent qualitative medium for recording the pattern. Conversion of relative blackening to X-ray intensities for quantitative analysis entails skill.

Diffractometry: Adding the diffractometer to the basic diffraction unit provides a means by which the interpretation is speeded and facilitated. A sensitive Geiger counter tube, in place of the film, receives the reflections from the specimen. Subsequent electronic integration and amplification of these impulses serve as the means of developing peaks



Case No. 63

Kemp Oriad Dryer Gives "Most Satisfactory Service" Guarding Spencer Control Board

How Kemp assures round-the-clock operation at Spencer Chemical

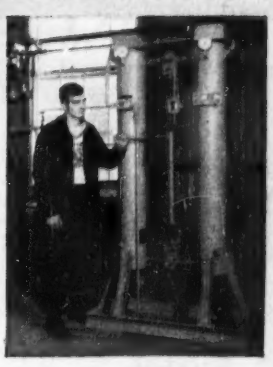
The Spencer Chemical Co., Charlestown, Ind., operates 24 hours a day, 7 days a week, making nitrogen compounds for the fertilizer industry. Heart of this operation is the master instrument board that controls all plant processes. These instruments are operated by compressed air, which must be dried to prevent rust and corrosion within the controls.

Kemp Offers Continuous Protection

Spencer uses a Kemp Oriad Dryer to dry all the air required and completely protect the delicate instruments from moisture damage. Since its installation in 1950, this Kemp unit has needed no service of any kind. And Spencer is delighted with Kemp's ease of operation! Mr. N. S. Whitaker, Works Manager, commenting on Kemp's "most satisfactory service," says, "Operation is simplicity itself. All we have to do is switch a lever once a week. Capacity is ample for one week of maximum flow, on a 24-hour 7-day operation."

Kemp Dryers for Every Purpose

Kemp offers a variety of dryer models to meet all problems. Designed to dry air to sub-zero dew points at low cost, these efficient dryers embody the engineering knowledge gained from Kemp's many years of experience. They are available with manual, semi-automatic, or fully automatic tower reactivation. In addition, Kemp will prescribe the proper desiccant for each specific drying job. If you have a problem involving the drying of air, gases, or liquids, contact Kemp engineers now.



Only operation required on Kemp Oriad Dryer is moving lever once a week to switch flow of air to second column. First column is reactivated by heat during the week.

***For more complete facts and technical information, write for Bulletin D-27 to:* THE C. M. KEMP MFG. CO., 405 East Oliver Street, Baltimore 2, Md.**

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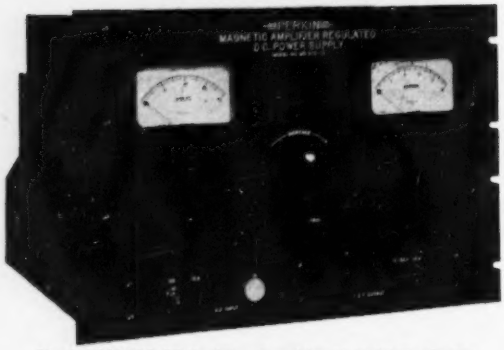

Model MR532-15 (without cabinet) 5-32 V. @ 15a.
Regulated, Stabilized & Filtered to 1%

Partial List of Other Magnetic Amplifier Regulated Power Supplies

MODEL NO.	VOLTS	AMPS.
M60VMC	0-32	25
MR1040-30	10-40	30
MR1032-50	10-32	50
MR2432-200	24-32	200

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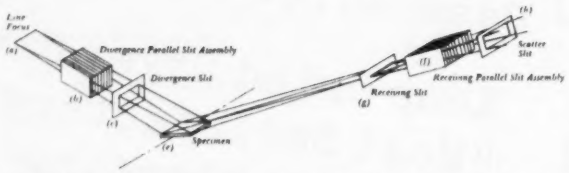
BRIEFS—CONTINUED



on a chart corresponding to the diffraction lines on the film pattern. This newer method is extremely rapid—providing better accuracy, more information and guaranteeing unequalled reproducibility with greater ease than with other methods of analysis.

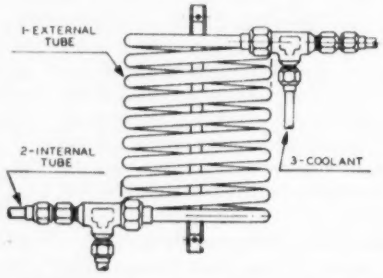
Spectrography: Utilizing facilities provided in the basic diffraction unit, simple connections can be made for high-tension operation of a specially designed external high intensity X-ray tube. This X-ray tube, together with a specially designed chamber working in conjunction with the Wide Angle Goniometer of the Diffractometer provides the instrumentation necessary for Spectrography. The X-ray tube excites X-radiations of the components of a specimen and spectrograms are obtained when those X-rays fall upon a single crystal acting as an analyzer. Heterogenous wavelengths derived from the sample are thus separated into components, each of which is singularly distinguishable. The apparatus provides qualitative as well as quantitative data on the relative percentage of elements present.

Electron Microscopy: The "EM-100" provides continuously variable enlargements, 1000x through 60,000x, with resolving power of better than 50 Angstroms . . . Techniques may be instantly changed from microscopy to electron diffraction patterns. (*From new 66-page brochure, "Research and Control Instruments," North American Philips Co., Inc., Mt. Vernon, N. Y.*)

For this literature circle **614** on inquiry card.

Heat-transfer Calculations

Selecting and sizing dual heat-transfer coils to condense steam has been a troublesome problem. Information needed includes . . . amount of sample, pressure of steam, water temperature. Calculate amount of heat to be removed,



amount of cooling water. . . . Choose coil from Fig. I which has required coolant capacity. . . . Check Fig. II to determine if coil can handle flow at the given pressure. (*From new Bulletin* 8310B1, *Parker Appliance Co.*, 17325 *Euclid Ave., Cleveland, Ohio.*)

For this literature circle **615** on inquiry card.

Ferromagnetic Cores

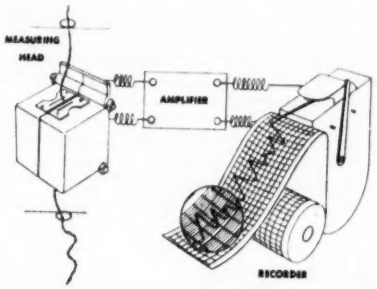
Ceramag Cores are ferromagnetic cores molded from carefully selected mixtures of metallic oxide powders. Special handling of these powders during the sintering process promotes cubic crystal growth. The finished result is a ceramic material having low eddy current loss and high-permeability characteristics far superior to conventional cores for applications requiring high permeability for relatively

low flux densities and medium frequencies. Cores are molded or extruded to the desired shape and can be ground on flat surfaces if required. Standard Stackpole Ceramag Core types provide permeability on the order of 10 to 1 or even higher by comparison with conventional iron cores. In addition to their high permeability, they have much higher resistance, are materially smaller and operate much cooler due to the absence of eddy current losses resulting from their high resistivity. (*From new 54-page Catalog RC-9, Stackpole Carbon Co., St. Marys, Pa.*)

For this literature circle **616** on inquiry card.

Yarn Uniformity Analyzer

Modern way to quality control of yarn, roving and sliver . . . is the new Uniformity Analyzer . . . consists of amplifier,



measuring heads, oscillograph, material drive unit, and material handling equipment . . . As yarn passes through measuring head, variations in weight per unit length are recorded. (*From new 4-page brochure ED-21401, Brush Electronics Co., 3405 Perkins Ave., Cleveland, Ohio.*)

For this literature circle **617** on inquiry card.

NEW GRAYHILL 2-2 TEST BOARD further simplifies your testing!

TEST YOUR RESISTORS, CAPACITORS, GERMANIUM DIODES, GENERAL TEST LEADS, ETC., IN A SPLIT SECOND. TIGHT-GRIP CLIPS GUARANTEE PERFECT CONTACT. BODY IS MOLDED OF GENERAL PURPOSE PHENOLIC. AVAILABLE WITH BANANA PLUGS ON ¾" CENTERS. BANANA PLUGS AND CLIPS PLATED. LOOK FOR THE NAME GRAYHILL— IT'S A STANDARD

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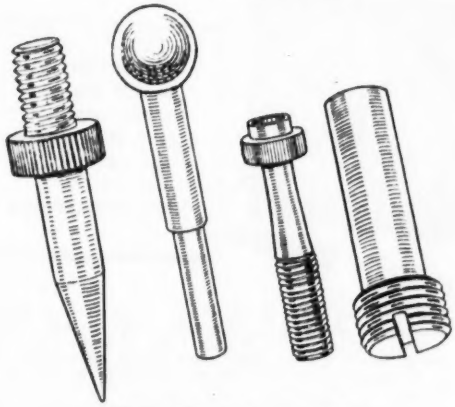

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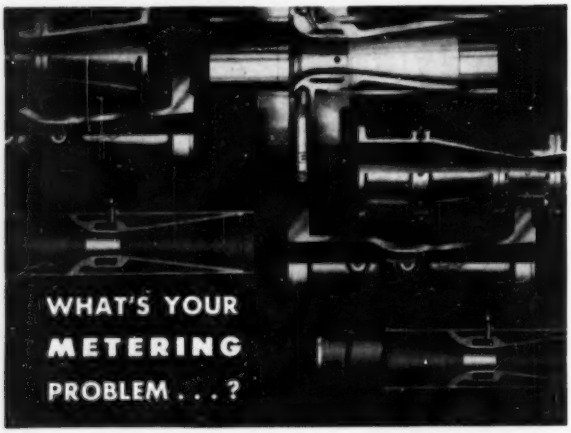

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For more information circle **132** on inquiry card.

Radioisotopes in Medicine

At the present time internal medical use of radioactive substances, except for research studies, is limited primarily to radioiodine-131, radiophosphorus-32, radiosodium-24 and radiogold-198.

Radioiodine-131 is used for thyroid gland function tests, for treatment of hyperthyroid conditions and some thyroid cancers, for treatment of a limited group of patients with heart disease, for localizing brain tumors and for blood volume studies.

Radiophosphorus-32 is used to treat selected patients having leukemia or polycythemia vera, to localize rapidly growing soft tissue masses such as breast tumors, and to determine the extent of tumors during brain surgery.

Radiosodium-24 is used for diagnostic tests involving the rate or amount of blood flow through arteries and veins, for radiocardiography, and for determining the rates of electrolyte diffusion through tissue.

Radiogold-198 is used in treatment of certain cancers of the lymphatic system and of the body cavities. (*From new 4th issue of "Nucleus," Nuclear Instrument & Chemical Corp., 229 W. Erie St., Chicago, Ill.*)

For this literature circle **618** on inquiry card.

Optical Gaging

Optical gaging provides a visual means of comparing simultaneously the enlarged shadows of a shaft and of a transparent measuring scale. The Universal Shaft Checking Fixture carries an individual transparent scale for each shaft design. The scale (called a reticle) is referenced with the shaft which is also held by the fixture. If the part con-

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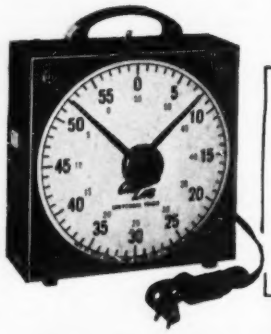

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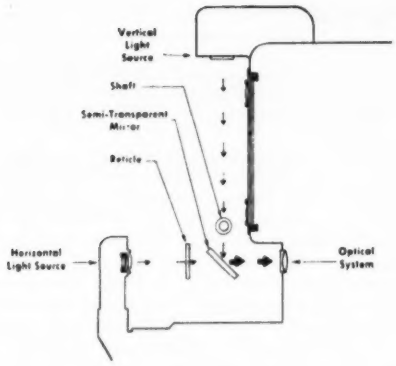

forms to specifications, the enlarged image of the reticle line appears within the tolerance gap on the chart gage. (*From new 4-page Bulletin 55SC Optical Gaging Products, 26 Forbes St., Rochester, N. Y.*)

For this literature circle **619** on inquiry card.

dba, dbm, dbRN, dbx, dbw

The decibel is used commonly to express a ratio between two quantities of power. To change the ratio to absolute values of power, it is necessary to use some reference power.

The most common reference power in the telephone industry is the milliwatt . . . "decibels above or below one milliwatt" is usually abbreviated ± dbm.

Dba and dbRN refer to noise and interference. In telephone circuits a 1,000-cycle tone having a power level of 10^{-12} watt, or –90 dbm, has negligible interfering effect. Therefore, db above a reference noise of 10^{-12} watt at 1,000 cycles is abbreviated as dbRN. A later improved type of

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All replies will be held in strictest confidence, and reports will be made promptly. This proposal will not be repeated, and since we cannot accept all ideas, immediate response is suggested. Patent attorneys need not reply. We are interested only in working directly with owners who have a good, solid device to sell and one that can make us both some money.

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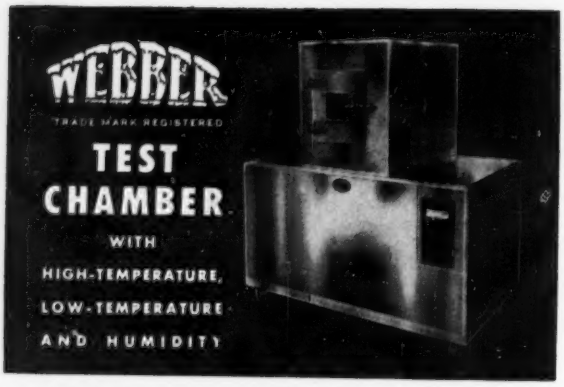

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Write for more complete information

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BRIEFS—CONTINUED

telephone handset had about 5-db improvement over early models, so that a new reference noise power of −85 dbm, or $10^{-11.5}$ watt was needed. The db level referred to this power is called dba.

Volume units (vu) are used to monitor program volume. A vu meter is a db meter calibrated in dbm, but so damped that it cannot follow every fluctuation in program power.

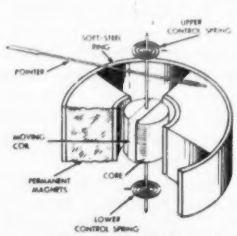
Dbx indicates crosstalk coupling in telephone circuits; the reference power is 90-dba power impressed on the disturbing circuit.

Dbw are decibels referred to 1 watt; dbk are decibels referred to 1 kilowatt; dbRAP means decibels above a reference acoustical power of 10^{-16} watt; dbv are decibels referred to 1 volt. (*From "Demodulator," Vol.* 3 *No.* 1, *Lenkurt Electric Co., San Carlos, Calif.*)

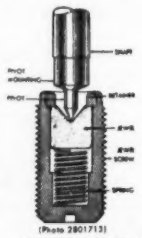
For this literature circle **620** on inquiry card.

D-c Indicating Instruments

Type DP-12 instruments is a new line of ¼% instruments . . . are suitable for laboratory use as well as for field appli-

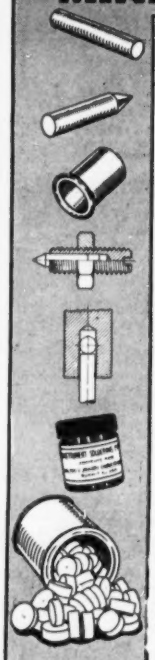


Basic parts of concentric-magnet mechanism used in DP-12 instruments



Cross section showing spring-mounted jewel

MINIATURE PARTS



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cations and production tests where high precision is essential. Features: Spring-mounted jewel bearings, concentric magnet mechanism, 5½-inch scale. (*From new 8-page Bulletin GEC-979A, General Electric Co., Schenectady, N. Y.*)

For this literature circle **621** on inquiry card.

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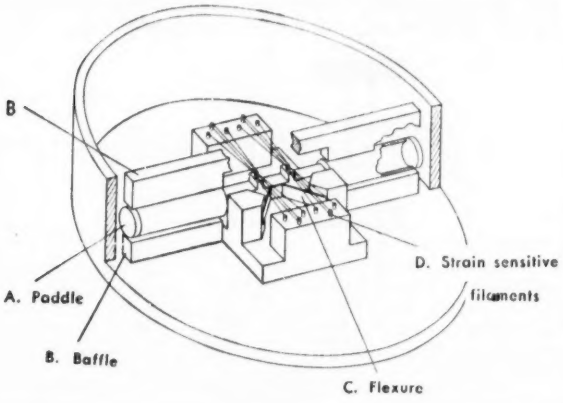
A design has been achieved which permits study of angular acceleration under rugged field conditions . . . an angular accelerometer in which a liquid mass serves as the rotor. When the case is subjected to angular acceleration, inertia forces cause the liquid to rotate and develop a hydrostatic pressure against the hollow-cylinder paddle as the liquid is forced between the paddle and baffles. The paddle will



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LOOK TO MARSHALLTOWN FOR ONE OF THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

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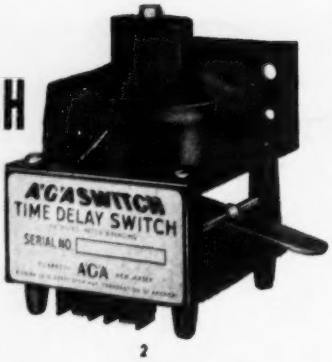
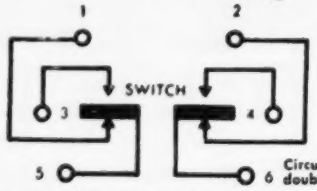
...to introduce time delays into electrical circuits





Circuit diagram, double pole unit

- Adjustable—time delays from 0.1 second to 5 or more minutes
- Manually operated, pneumatically timed
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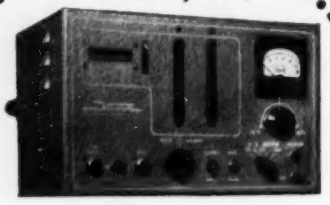

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For more information circle **144** on inquiry card.

BRIEFS—CONTINUED

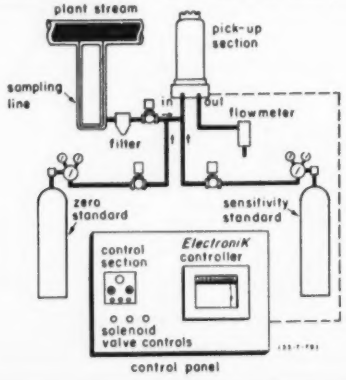
deflect angularly until the elastic restraint of the flexure and pick-off balances the forces on the paddle . . . The low mass of the paddle insures insensitivity to g shock. (*From new No. 26 issue of "Instrument Notes," Statham Labs, 12401 W. Olympic Blvd., Los Angeles, Calif.*)

For this literature circle **622** on inquiry card.

Plant-stream Gas Analyzers

All hetero-atomic gases have infrared absorption bands produced by vibrations of their molecular bonds. Since these bands are related to molecular structure, the infrared spectrum of a hetero-atomic gas is a characteristic property that distinguishes it from all other gases.

Extensive catalogs of over 3,000 pure materials have been compiled to assist those who wish to identify unknown compounds by infrared means. In general, any of these *gases* that can be analyzed by infrared spectrographic means can also be identified with the *Liston-Becker* analyzer.



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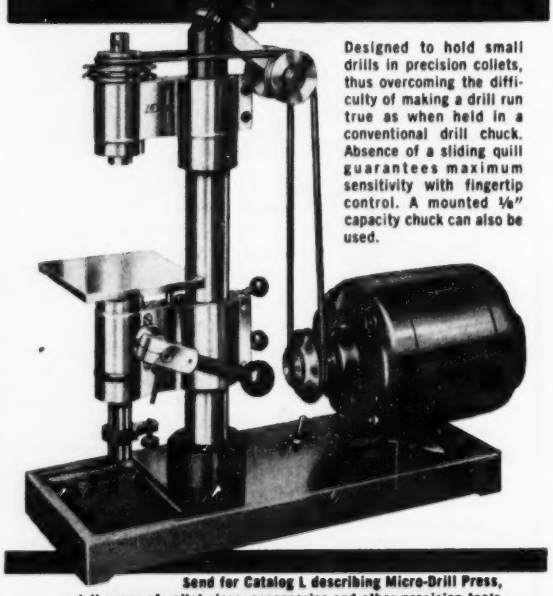
FOR VERY SMALL HOLES DOWN TO .002



Designed to hold small drills in precision collets, thus overcoming the difficulty of making a drill run true as when held in a conventional drill chuck. Absence of a sliding quill guarantees maximum sensitivity with fingertip control. A mounted ⅛" capacity chuck can also be used.

Send for Catalog L describing Micro-Drill Press, full range of collet sizes, accessories and other precision tools

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For more information circle **145** on inquiry card.

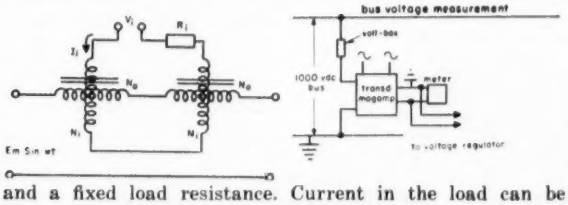
Some *liquid* analyses may be performed with this instrument. Where the liquid molecule for which it is desired to analyze has a vapor pressure greater than 30 mm at 25 C, no special problem is presented. Where the molecule does not have sufficient vapor pressure, a gas having overlapping bands of infrared radiation can frequently be used as a reference to provide a basis for analysis.

Specifically, *Liston-Becker* analyzers are being used for laboratory and continuous plant stream analysis for CO, CO_2, SO_2, toxic gases, ethylene, butadiene, methane, CH_4, N_2O, etc. (*From new 4-page Data Sheet* 10.15-10, *Minneapolis-Honeywell, Ind. Div., Phila. 44, Pa.*)

For this literature circle **623** on inquiry card.

Transductor Magamps

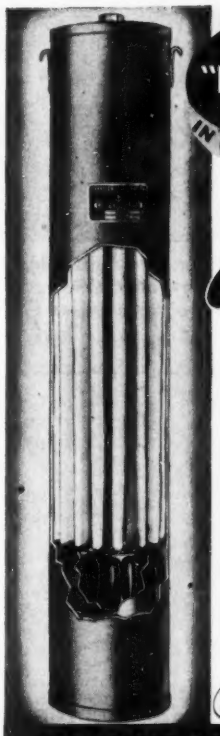
Westinghouse transductor "Magamps" are magnetic amplifiers developed to act essentially as instrument transformers in the field of d-c. instrumentation and control . . . is a magnetic amplifier of the simple saturable-reactor type. Operation depends on use of a series-connected variable reactance in a circuit with a fixed a-c. supply voltage



and a fixed load resistance. Current in the load can be a-c. or d-c., depending on use of a rectifier.

Transductor circuit consists of two reactors of N_0 turns; input or control windings N_1 turns; I_1 represents control current. . . . Transductor "Magamps" are applicable to the measurement of d-c. currents and voltages requiring isolation. (*From new Technical Data* 52-601, *Westinghouse Electric Corp., E. Pittsburgh, Pa.*)

For this literature circle **624** on inquiry card.



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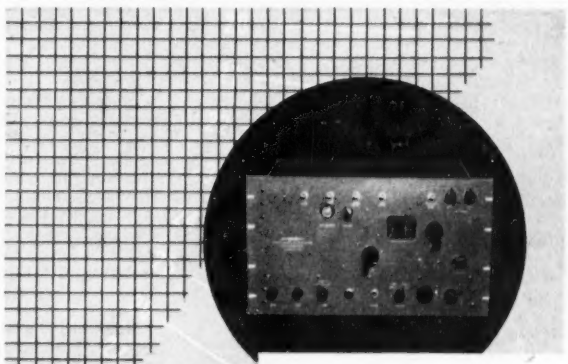

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MANUFACTURERS' NEW LITERATURE

In this department we report new literature, pertaining to instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on Page 503.

Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

AUTOMATION

Multiple-Generator Drives. New 8-page illustrated Bulletin GEA-5712A describes installation, operation, and construction of maker's multiple-generator sectional drives for paper machines.—General Electric Co., Schenectady 5, N. Y.

Circle **401** on inquiry card.

Null-balance Recorder-controller. New 8-page illustrated Bulletin F-451 gives features and specifications of maker's null-balance contact-type recorder-controller designed for resistance-bulb thermometry but useful for other process variables.—Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Phila., Pa.

Circle **402** on inquiry card.

Servomechanisms. New 20-page illustrated Bulletin R-11 gives application of nonlinear techniques to servomechanisms, including instruments servos and ½-hp. servos.—Cook Electric Co., 2700 Southport Ave., Chicago, Ill.

Circle **403** on inquiry card.

Photoelectric Control. New 8-page illustrated Catalog 53 describes maker's photoelectric controls including "Fail Safe" high-speed and ultrasensitive controls with electronic timers and safety relays.—Autotron Co., Box 772-Q, Danville, Ill.

Circle **404** on inquiry card.

Program Controllers. New 4-page illustrated Bulletin 48 presents maker's program controllers for production and quality control testing, research and development.—Tinius Olsen Testing Machine Co., 1116 Easton Rd., Willow Grove, Pa.

Circle **405** on inquiry card.

Process Control. New 4-page illustrated Bulletin F 5633-1 describes maker's complete line of instruments for industrial process control, including "electronic link" pickup.—Wheelco Instruments Div., Barber-Colman Co., Rockford, Ill.

Circle **406** on inquiry card.

Saturating Servomechanisms. New 16-page Bulletin R-13 discusses design considerations of a saturating servomechanism, indicating relationship between saturated and unsaturated zones and propounding method of compensating for effects of torque and velocity saturation in choosing linear parameters.—Cook Electric Co., 2700 Southport Ave., Chicago, Ill.

Circle **407** on inquiry card.

Predetermined Counter, Switch. New 32-page illustrated Bulletin 202-203-51 presents schematic diagrams and operation of maker's "Cyclo-Monitors" predetermined counting and switching units with automatic recycling. Write on company letterhead.—Counter and Control Corp., 5225 W. Electric Ave., Milwaukee, Wis.

Circle **408** on inquiry card.

VALVES

Balanced Diaphragm Valves. New 2-page illustrated Specification Sheet 425 lists specifications, application, and uses of maker's pressure-balanced diaphragm motor valve for outlet-pressure regulation.—Minneapolis-Honeywell Regulator Co., Indus. Div., Phila. 44, Pa.

Circle **409** on inquiry card.

Transfer Switches, Solenoid Valves. New 36-page illustrated Bulletin 528 presents specifications and applications of maker's line of automatic switches, including switch panels and starting panels, close differential relays, time-delay relays, and load transfer relays. Also presented is maker's large line of solenoid valves.—Automatic Switch Co., Orange, N. J.

Circle **410** on inquiry card.

Solenoid Valves. New 2-page illustrated Technical Bulletin 106 lists specifications for cast-iron or cast-steel solenoid valves, "Series 4000."—Atkomatic Valve Co., 545 W. Abbott St., Indianapolis, Ind.

Circle **411** on inquiry card.

Back-pressure Control Valves. New 2-page illustrated Bulletin KD 1 includes application, operation, construction and features for maker's "Type KD" automatic back-pressure control valve.—A. W. Cash Valve Mfg. Corp., 666 E. Wabash Ave., Decatur, Ill.

Circle **412** on inquiry card.

Twin Seal Valves. New 64-page illustrated catalog presents description and technical data of maker's hydraulic and gas check valves and hand pumps, instrument diaphragms seals, seal service bench, and pressure instrument test unit.—Mansfield & Green, Cleveland 14, Ohio.

Circle **413** on inquiry card.

Corrosive-fluid Valves. New 1-page bulletin describes and gives specifications and diagrams of maker's 1- and 2-inch polyethylene valves for highly corrosive fluids.—Vanton Pump and Equipment Corp., Empire State Bldg., New York, N. Y.

Circle **414** on inquiry card.

Valves. New 8-page illustrated Booklet "How to Get What You Need When You Order a Valve," lists data required for ordering manual valves, power operated valves, instrument-operated valves, pressure and temperature regulators, and traps and level controls.—Cooper Alloy Fdry. Co., Hillside, N. J.

Circle **415** on inquiry card.

Pilot-operated Valves. New 6-page illustrated Bulletin 57 lists specifications, features, and schematic diagrams of maker's ¾-in. pilot-operated remotely-controlled 4-way valves.—Pantex Mfg. Corp., Pawtucket, R. I.

Circle **416** on inquiry card.

TEMPERATURE

Thermocouple Assemblies. New 6-page illustrated Bulletin P1261 gives description, specifications, and properties table for maker's new thermocouple assemblies with metal-ceramic "LT-1" protecting tubes.—Bristol Co., Waterbury 20, Conn.

Circle **417** on inquiry card.

Thermostatic Bimetals. New 64-page illustrated bulletin describes 22 uses of maker's bimetal as actuating elements in temperature responsive devices. Also engineering data for element design and selection.—W. M. Chace Co., 1601 Beard Ave., Detroit, Mich.

Circle **418** on inquiry card.

Thermocouple, Lead Wire. New 16-page illustrated Catalog 953 covers calibration and ratings of maker's thermocouple wire, aircraft electrical cable, lead wires, heating elements, and fixture wire. Write on company letterhead to—Lewis Engineering Co., Naugatuck, Conn.

Circle **419** on inquiry card.

Thermocouple and Extension Wire. New 8-page illustrated Bulletin 31 describes maker's thermocouple and extension wires for standard pyrometric work. Includes tables of calibration, gages, insulation characteristics, resistances, weights, electrical properties and conduit capacities.—Thermo Electric Co., Inc., Saddel River Township, Rochelle Park P. O., N. J.

Circle **420** on inquiry card.

Laboratory Thermometers. New 4-page illustrated Catalog A-53 lists scale range, description, sizes and prices of maker's precision glass-stem thermometers.—Brooklyn Thermometer Co., Springfield Gardens, L. I., N. Y.

Circle **421** on inquiry card.

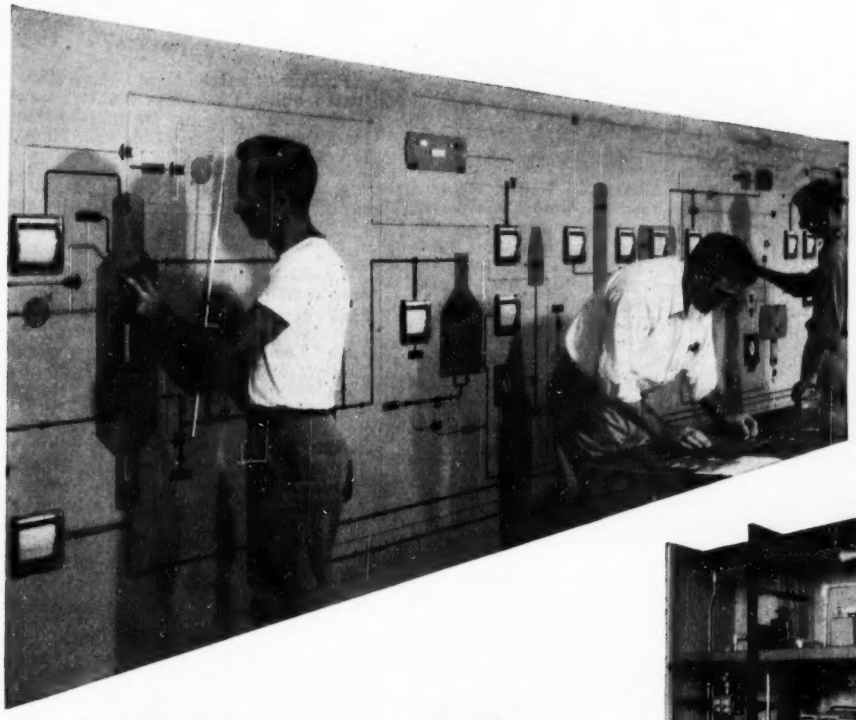
Dial Thermometers. New 8-page illustrated Catalog details specifications and features of maker's types of dial thermometers for industrial and laboratory use, and accessories.—Rochester Mfg. Co., Rochester 10, N. Y.

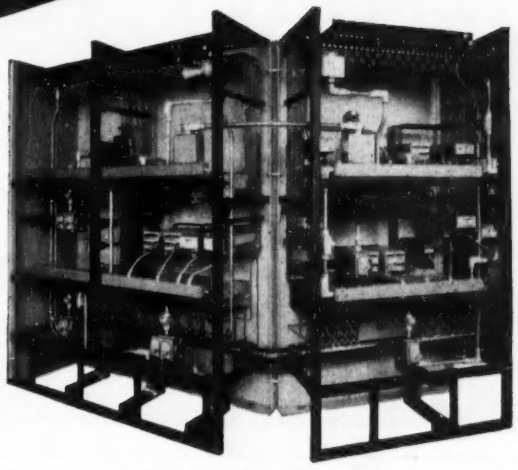
Circle **422** on inquiry card.

Creative Contributions to Centralized Process Control . . .

GRAPHIC PANELS

by FOXBORO





Typical back-of-panel view. Note open framework construction (easily enclosed if desired), terminals tagged for quick identification in field, neat arrangement of tubing and wiring, full accessibility to all instruments.

Years of experience in panel design and construction have equipped Foxboro Panel Engineers with many exclusive techniques . . . methods which bring you unequalled performance in centralized process control.

One typical feature is the use of aluminum strips and shapes, three-dimensional in effect, in bright, permanent colors, to symbolize flow lines and vessels. These are securely attached over the background finish, yet may readily be rearranged when necessary without marring the finish or leaving ugly holes. (If you prefer, painted graphic panels can be furnished.)

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For more information circle **149** on inquiry card.

NEW LITERATURE

Precision Thermoregulators. New 1-page illustrated Bulletin 11 describes maker's "Models 117-TS and 117-RS" thermoregulators that use Hg-in-glass with contacts to control within 0.004 deg. F.—Scientific Development Co., Box 795, State College, Pa.

Circle **423** on inquiry card.

PRESSURE, VACUUM

Pressure, Vacuum Gages. New 124-page illustrated Catalog 300 includes design, ranges, specifications, applications and accessories for maker's large "Ashcroft" line of indicating and recording gages for pressure, vacuum or compound.—Manning, Maxwell & Moore, Inc., Stratford, Conn.

Circle **424** on inquiry card.

Bourdon-tube Gages. New 16-page illustrated bulletin presents principle of operation, special design features, characteristics, cross sectional description, materials, heat treatment, P-V-T determination, and directions for proper use of maker's Bourdon-tube precision pressure gages.—Heise Bourdon Tube Co., Inc., Brook Rd., Newtown, Conn.

Circle **425** on inquiry card.

Differential Transmitter. New 4-page illustrated Bulletin 2753 covers principles, description, applications, operation of maker's low-head differential transmitter.—Hagan Corp., Hagan Bldg., Pittsburgh 30, Pa.

Circle **426** on inquiry card.

Vacuum Gages. New 2-page illustrated bulletin lists features, specifications, and response ratings for various elements and compounds of maker's "Model 511 Alphatron" vacuum gage.—National Research Corp., 70 Memorial Dr., Cambridge, Mass.

Circle **427** on inquiry card.

Differential-pressure Potentiometer. New 2-page illustrated Bulletin 508 lists specifications and dimensions of maker's diaphragm bellows-type differential-pressure potentiometer in ranges from 0-1 to 0-30 psi.—Bourns Laboratories, 6135 Magnolia Ave., Riverside, Calif.

Circle **428** on inquiry card.

Pressure Transducer. New 2-page illustrated Bulletin 154-1-101A includes description, control circuit schematic, water-depth oscillogram and specifications of maker's "Model DP-7" sensitive differential-pressure transducer with range from 0.5 to 15 psi.—North American Instruments, Inc., 2420 N. Lake Ave., Altadena, Calif.

Circle **429** on inquiry card.

Vacuum Pump Care. New 16-page illustrated Bulletin 755 presents care of vacuum pumps, including principles of operation, directions for starting, stopping, and maintenance, installation data and directions for choosing vacuum system.—F. J. Stokes Machine Co., 5500 Tabor Rd., Phila., Pa.

Circle **430** on inquiry card.

Pressure, Strain Transducers. New 10-page illustrated catalog presents maker's displacement, pressure and differential transducers; linear and angular accelerometers and strain gages. Includes explanation of induction principle.—General Scientific Corp., 603 N. La Brea Ave., Los Angeles, Calif.

Circle **431** on inquiry card.

Low-pressure Rupture Disks. New 4-page "Newsletter," No. 17, features articles on low-pressure rupture disk of gold, cavity viewing instruments, transfer volt-ammeter, and screen printing with precision metals.—Engelhard Industries, 113 Astor St., Newark, N. J.

Circle **432** on inquiry card.

Pressure Switch. New 1-page illustrated bulletin presents maker's new "BM series" pressure switches.—Miller-Robinson Co., 7007 Avalon Blvd., Los Angeles, Calif.

Circle **433** on inquiry card.

LEVEL

Liquid-Level Measurement and Control. New 24-page illustrated Bulletin 1160 describes maker's 12 different systems for measuring and controlling liquid level, including transmission, control, and handling of difficult liquids.—Minneapolis-Honeywell Regulator Co., Indus. Div., Phila. 44, Pa.

Circle **434** on inquiry card.

Water Column Gages. New 2-page illustrated Data Sheet 232 describes principle of operation and features of maker's water columns that give positive alarm signals if boiler water falls too low or rises too high.—Jerguson Gage & Valve Co., 80 Fellsway, Somerville, Mass.

Circle **435** on inquiry card.

Level, Density Gages. New 8-page illustrated Bulletin 104 presents features and applications for specific gravity and level applications using maker's radioactivity detectors utilizing null measurement.—Ohmart Corp., 2236 Bogen St., Cincinnati, Ohio.

Circle **436** on inquiry card.

Ultrasonic Level Indicators. New 8-page illustrated Bulletin S-68 describes operations of liquid-level indicator systems using ultrasonic pulse reflection, and maker's transducer.—Bogue Electric Mfg. Co., Paterson 3, N. J.

Circle **437** on inquiry card.

FLOW

Rotameters. New 4-page illustrated Bulletin 18-RG treats construction, operation, sizes, dimensions, capacities of maker's "Safeguard Rotameters" for fluid rate of flow.—Schutte & Koerting Co., Cornwells Heights, Bucks County, Pa.

Circle **438** on inquiry card.

Flowmeters. New 52-page illustrated bulletin covers descriptions, specifications and operation of maker's indicating, recording, controlling and integrating flowmeters.—Brooks Rotameter Co., Lansdale, Pa.

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Flow Limit Alarms. New 2-page illustrated Bulletin 165 gives specifications and principle of maker's electronic "Flo-Gard" high or low flow

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alarms for use with rotameters, manometers, etc.—Brooks Rotameter Co., Lansdale, Pa.

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Plastic Pumps. New 8-page illustrated bulletin presents diagrams, applications, operating specifications, available materials for maker's "Flexi-liner" plastic pump for corrosive fluids and abrasive slurries.—Vanton Pump & Equipment Corp., Empire State Bldg., New York, N. Y.

Circle **441** on inquiry card.

WEIGHT

Crane Scale. New 6-page illustrated Bulletin W-2 covers features, specifications, and uses of maker's crane-scale weight indicator.—W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif.

Circle **442** on inquiry card.

Scale Feeders. New 8-page Bulletin TA-1002-M covers features, applications and operation of maker's "Merchen" scale feeder and meter for dry chemicals, belt feeders, and continuous weighing.—Wallace & Tiernan, Box 178, Newark, N. J.

Circle **443** on inquiry card.

ACCELERATION, VIBRATION

Strain Measurement. New 24-page illustrated Bulletin, "The Measurement of Strain," presents principles, equipment and types of strain measurement, including electric strain gages and measurement of static and dynamic strain.—Hathaway Instrument Co., 1315 S. Clarkson St., Denver, Colo.

Circle **444** on inquiry card.

Angular Accelerometers. New 4-page illustrated issue No. 26 of "Instrument Notes" describes design considerations for liquid-rotor angular accelerometer for field use.—Statham Labs., Inc., 12401 W. Olympic Blvd., Los Angeles, Calif.

Circle **445** on inquiry card.

Vibration Indicators. New 12-page illustrated bulletin presents distributor's "Anson" vibrometer, DWA high speed pulse register, valve operated counting unit, high speed electro-mechanical counter, hand-held vibrograph, reed tachometer, and dosimeter charging unit.—American Tradair Corp., 405 Lexington Ave., New York 17, N. Y.

Circle **446** on inquiry card.

Vibration Machines. New 6-page illustrated bulletin presents maker's three types of vibration machines with horizontal, vertical and circular motion.—Waugh Equipment Co., 420 Lexington Ave., New York, N. Y.

Circle **447** on inquiry card.

Vibration Isolators. New 4-page illustrated Bulletin 538 gives features, purpose, application, load ranges, and performance of maker's "Series 670 and 297" shock and vibration isolators.—Barry Corp., 700 Pleasant St., Watertown, Mass.

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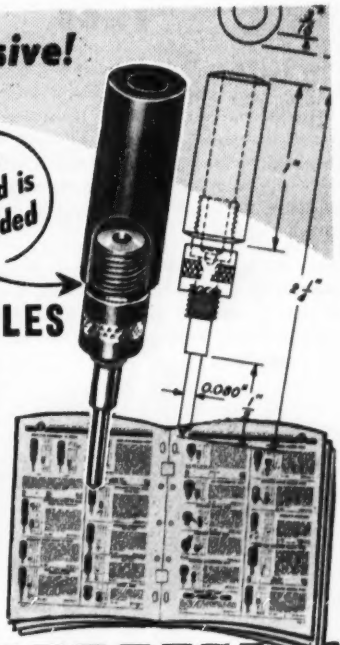

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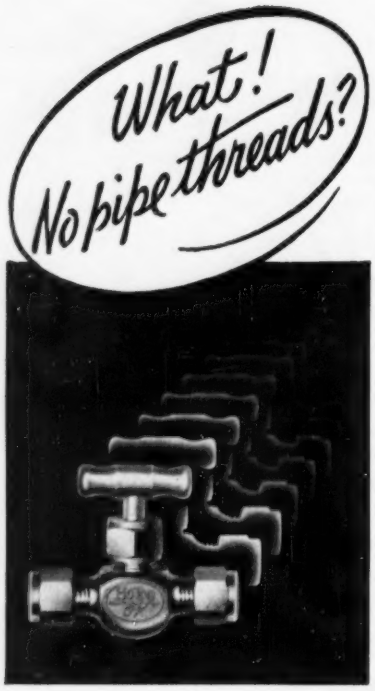

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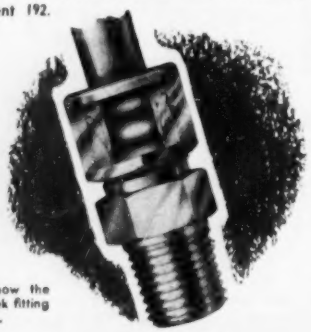

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MANUFACTURERS' NEW LITERATURE

Leveling Vibration Mountings. New 4-page illustrated Bulletin DR-154-10 gives features of maker's mounting and leveling vibration-isolating device. —Barry Corp., 700 Pleasant St., Watertown, Mass.

Circle **449** on inquiry card.

Shock Mounting. New 2-page Bulletin 1202B covers description, performance, and construction of maker's "Met-L-Flex" shock mount for mobile and industrial uses.—Robinson Aviation, Inc., Teterboro, N. J.

Circle **450** on inquiry card.

RECORDING

Oscillographic Recording. New 6-page illustrated Bulletin 107 gives features and specifications for maker's 5000-cps. carrier-type amplifier system for static and dynamic recording. —Heiland Research Corp., 130 E. Fifth Ave., Denver, Colo.

Circle **451** on inquiry card.

Oscillograph Recording. New 38-page illustrated catalog containing Bulletins 1 to 11 presents technical data and specifications for maker's 4-, 2-, and 1-channel oscillograph recorders.—Sanborn Co., Indus. Div., 195 Massachusetts Ave., Cambridge, Mass.

Circle **452** on inquiry card.

Oscillograph Recording. New 12-page illustrated issue (Vol. 7. No. 4) of "Recordings" features articles on oscillograph recording of sub-surface oil drilling phenomena, mass spectrometer use in process development, auto body vibration research, and new pressure pickups and oscillograph of maker.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **453** on inquiry card.

Magnetic Recording for Computers. New 4-page bulletin presents new principle in magnetic recording of information for automatic computing machines based on revolving sheet-metal drum with 100,000-word capacity.—Logistics Research, Inc., Redondo Beach, Calif.

Circle **454** on inquiry card.

Wax Chart Paper. New 4-page bulletin gives principle, specifications, features and comparison of maker's new "Waxon" recording chart paper with ink—chart method. "Waxon" recording system operates on principle of colored paper stock covered with lighter colored wax, which becomes transparent in spot where pressure is applied, permitting basic color to show through.—Waxon-Carboff, Inc., Rochester, N. Y.

Circle **455** on inquiry card.

Two-channel Tape Recorder. New 4-page Bulletin DS-3-1-5 presents features, performance, and specifications of maker's "Model 311" two-channel recorder with wide-range direct-recorded track, frequency response from 300 to 70,000 cycles, and FM carrier track with response from 0 to 5000 cycles.—Ampex Corp., 934 Charter St., Redwood City, Calif.

Circle **456** on inquiry card.

COMPUTING

Digital Computer. New 4-page illustrated Bulletin CEC-3100 lists principal features, decimal notations, command list, memory capacity, speed, coding, operation and equipment of maker's new "Model 30-203" electronic digital computer.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **457** on inquiry card.

Digital Differential Analyzer. New 8-page illustrated Bulletin 2-2 presents description, typical problems and solutions, mathematical characteristics, computer operations, input-output mechanisms and specifications of maker's digital differential analyzer "D-12."—Bendix Computer Div., Bendix Aviation Corp., 5630 Arbor Vitae St., Los Angeles, Calif.

Circle **458** on inquiry card.

Computer Techniques. New 8-page Bulletin "Computer Techniques in the Instrumentation Industries" presents operation and procedure of application of computers to galvanometer simulation, process-control simulation, and computer-controlled processes.—Berkeley Div., Beckman Instruments, Inc., 2200 Wright Ave., Richmond, Calif.

Circle **459** on inquiry card.

Digital Computer. New 1-page illustrated bulletin announces new "Alwac" fully automatic electronic digital computer.—Logistics Research, Inc., 141 S. Pacific Ave., Redondo Beach, Calif.

Circle **460** on inquiry card.

Mechanical Differentials. New 4-page illustrated bulletin describes features, performance, maximum speeds, and dimensional drawings of maker's mechanical differentials for computing, control, etc.—Ford Instrument Co., 31-10 Thomson Ave., Long Island City, N. Y.

Circle **461** on inquiry card.

RADIOACTIVITY

Nucleonic Instrumentation. New Vol. 57 No. 1 issue of "GE Review" features articles on nucleonic instrumentation, research instruments, electronic developments, semiconductors, etc.—General Electric, Schenectady 5, N.Y.

Circle **462** on inquiry card.

Radioactivity Scaler. New 2-page illustrated Specification Sheet 183 gives description and specifications of maker's "Model 183 Count-O-Matic" scaler.—Nuclear Instrument & Chemical Corp., 223 W. Erie St., Chicago, Ill.

Circle **463** on inquiry card.

Decade Scaler. New 4-page illustrated bulletin covers description, dimensions, and specifications of maker's new 30-Kc. decade scaler "Type 12100" and component E1T counter-tube decade-stage "Type 52214."—North American Philips Co., Inc., Mt. Vernon, N. Y.

Circle **464** on inquiry card.

X-ray Strain Measurement. New 20-page illustrated issue (Vol. 1, No. 3) of "Reporter" features articles on strain measurement by X-ray diffraction techniques, wide range goniometer alignment kit, helium chamber X-ray spectrograph, and crystallography articles available in microfilm or reprint.—North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y.

Circle **465** on inquiry card.

Decade Scaler, Diffractometer. New 8-page illustrated bulletin, "Research and Control News" presents maker's new 30-kc. decade scaler, new 90-degree diffractometer, and counting rate computer.—North American Philips Co., Inc., Mt. Vernon, N. Y.

Circle **466** on inquiry card.

GAGING, TESTING

Creep-testing Machines. New 12-page illustrated Bulletin 4208 presents maker's creep-testing machines, including lever arm and screw type, "Microformer" type, new SR-4 type automatic relaxation machines, and constant-strain-rate machine.—Baldwin-Lima-Hamilton Corp., Phila. 42, Pa.

Circle **467** on inquiry card.

Monochromatic Light Sources. New 4-page illustrated Bulletin ML-53 covers maker's standard monochromatic lamp, standard inspection lamp, laboratory and shop lamp, and dual-purpose adjustable lamp for precision lens inspection. Principle of optical-flat measurement with light-wave interference explained.—Acme Scientific Co., 1450 W. Randolph St., Chicago, Ill.

Circle **468** on inquiry card.

Amplifying Comparator. New 2-page illustrated bulletin presents maker's "Millimess" amplifying comparator.—George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.

Circle **469** on inquiry card.

Bore Profile Gage. New 6-page illustrated Bulletin CT.66 gives description and instructions for measuring profile and diameters with "Watts" 31SRA bore profile gage.—Engis Equipment Co., 431 S. Dearborn St., Chicago, Ill.

Circle **470** on inquiry card.

Optical Flats. New 1-page illustrated Bulletin Qf-Q lists sizes and prices of maker's fused quartz and pyrex optical flats with diameters from 1 to 10 inches.—E. & S. Optical Co., Hoboken, N. J.

Circle **471** on inquiry card.

Spur or Helical Gear Measurement. New 1-page illustrated bulletin describes timesaving formula for pin measurement of spur or helical gears.—Size Control Co. 2500 W. Washington Blvd., Chicago, Ill.

Circle **472** on inquiry card.

Gages. New 1-page bulletin lists do's and don'ts of reversible-thread gaging and explains gage care.—Size Control Co., 2500 W. Washington Blvd., Chicago, Ill.

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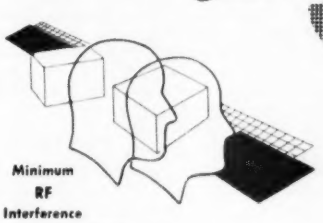

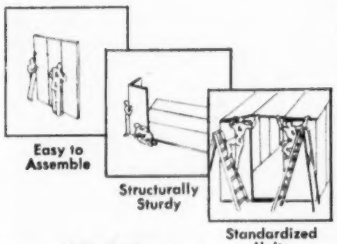

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MANUFACTURERS' NEW LITERATURE

Optical Flat. New 16-page illustrated bulletin presents principles of light-wave measurement, directions, interpretation of band patterns, theory of optical flat measurement, care and size of optical flats and maker's flats and accessories.—Acme Scientific Co., 1450 W. Randolph St., Chicago, Ill.

Circle **474** on inquiry card.

Optical Comparators. New 20-page illustrated Bulletin 5221 describes function, operation, construction and application of maker's optical comparators.—Jones & Lamson Machine Co., Springfield, Vt.

Circle **475** on inquiry card.

Inspection Lamp. New 1-page illustrated bulletin presents maker's rectangular illuminated inspection lamp with lens measuring 6½ by 6½ inches.—E & S Optical Co., 1426 Willow Ave., Hoboken, N. J.

Circle **476** on inquiry card.

Wire and Cordage Meter. New 2-page illustrated Bulletin 600 describes maker's new line of wire and cordage meters.—Olympic Instrument Laboratories, Cove, Wash.

Circle **477** on inquiry card.

DYNAMOMETERS

Dynamometer Systems. New 12-page illustrated Bulletin GEA-5923 gives operation, features and test data on maker's dynamometer systems for testing internal combustion engines, transmissions, torques converters, compressors, etc.—General Electric Co., Schenectady 5, N. Y.

Circle **478** on inquiry card.

Dynamometers. New 16-page illustrated Bulletin DB-1 presents construction, applications, and control of maker's liquid-cooled, absorption, motoring, universal and special-purpose dynamometers.—Eaton Mfg. Co., 3300 14th Ave., Kenosha, Wis.

Circle **479** on inquiry card.

Electric Brakes, Clutches. New 6-page illustrated Bulletin 6158 presents description, features and specifications of maker's various models of replaceable-face electric brakes and stationary-field electric clutches.—Warner Electric Brake & Clutch Co., Beloit, Wis.

Circle **480** on inquiry card.

LAB EQUIPMENT

Laboratory Equipment. New 20-page illustrated issue No. 54-1-53 of "Announcer" features articles on electro-analysis, centrifuges, operation-time recorders, "Carbotrane," and viscosimeters.—Burrell Corp., 2223 Fifth Ave., Pittsburgh, Pa.

Circle **481** on inquiry card.

Laboratory Centrifuges. New 5-page illustrated Bulletin LWA-205 describes distributor's "Westfalia Universal Laboratory Centrifuge LWA-205" which does all types of separation by means of four interchangeable bowls on one frame.—Centrico Inc., M & O Dept., 75 W. Forest Ave., Englewood, N. J.

Circle **482** on inquiry card.

Oxidation Apparatus. New 1-page preliminary information bulletins cover features and uses of maker's testing equipment, including JRS oxidation unit for determining amount of oxygen absorbed by rubber, plastics, fibers, etc. which are subject to deterioration; LGL Ozonator for measuring continuous flow of ozone for test of relative resistance of rubber materials to cracking; multicell heaters; and universal tensile testers for fibres or small specimens at constant elongation rate.—G. F. Bush Associates, Box 175, Princeton, N. J.

Circle **483** on inquiry card.

Electric Ovens. New 4-page illustrated Bulletin 1153 presents description and construction of maker's laboratory, pilot plant, and production ovens of gravity and recirculating type; also water baths.—Blue M Electric Co., 306 W. 69 St., Chicago, Ill.

Circle **484** on inquiry card.

Bore Stirrers, Tubing. New 4-page illustrated Catalog 53-1 presents dimensions, styles, sizes and prices of maker's line of precision bore stirrers, parts, and tubing.—Wilmad Glass Co., Franklin & Flower Sts., Landisville, N. J.

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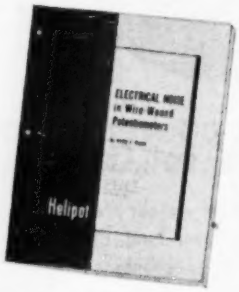

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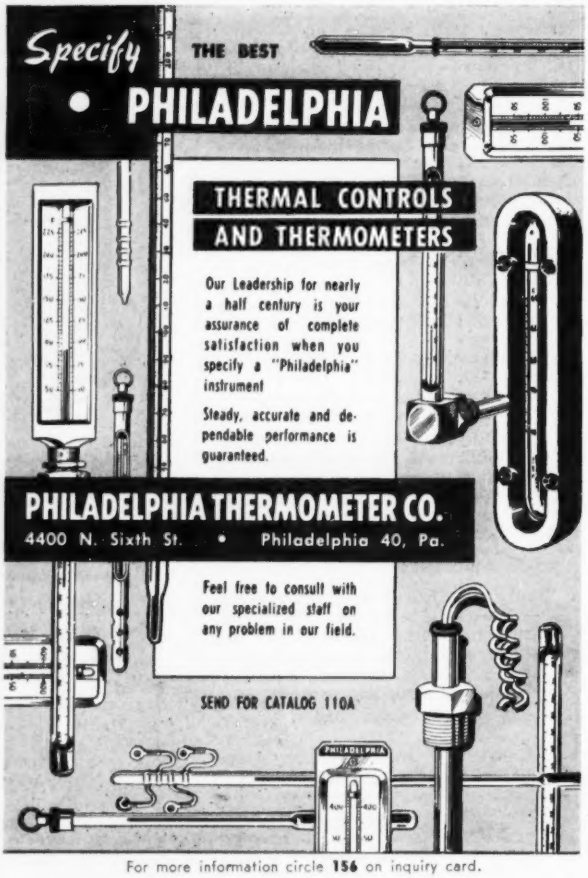

For more information circle **156** on inquiry card.

Laboratory Mixers. New 8-page illustrated bulletin presents specifications and applications of maker's "Models F, L, V, and ARL" laboratory mixers.—Mixing Equipment Co., Inc., 177 Mt. Read Blvd., Rochester, N. Y.

Circle **486** on inquiry card.

Balances. New 2-page bulletin describes distributor's new "Emson Model S-M" analytical balance.—E. Machlett & Son, 220 E. 23 St., New York, N. Y.

Circle **487** on inquiry card.

Laboratory Blenders. New 1-page Bulletin 405 describes maker's new yoke-type blenders for lab or small test samples.—Patterson-Kelley Co., Inc., E. Stroudsburg, Pa.

Circle **488** on inquiry card.

Laboratory Planning. New 28-page issue "Better Laboratory Planning" covers planning, ordering, bidding procedure for laboratories of all types.—Laboratory Equipment Section, Scientific Apparatus Makers Association, 20 N. Wacker Dr., Chicago, Ill.

Circle **489** on inquiry card.

Laboratory Apparatus. New 72-page illustrated Catalog 100 describes maker's line of laboratory apparatus and instruments, including constant-temperature baths, test instruments, and lab accessories.—Labline, Inc., 217 N. Desplaines St., Chicago, Ill.

Circle **490** on inquiry card.

Laboratory Furniture. New 28-page illustrated Catalog F-153 gives description, features and dimensions of distributor's line of sectional laboratory furniture, including cupboards, sinks, benches, etc.—Labline, Inc., 217 N. Desplaines St., Chicago, Ill.

Circle **491** on inquiry card.

Fused-quartz Apparatus. New 2-page illustrated bulletin lists physical and electrical properties, adaptability and typical products of maker of fused transparent and opaque quartz laboratory items.—American Fused Quartz Co., Inc., 18-20 Salem St., Dover, N. J.

Circle **492** on inquiry card.

Hot Plate. New 1-page illustrated Bulletin 26 describes maker's electric hot plate with 4-heat control.—Thermo Electric Mfg. Co., Dubuque, Iowa.

Circle **493** on inquiry card.

ANALYTICAL

CO_2 Analyzer. New 4-page illustrated bulletin gives description, operation, application and features of maker's new "Thermco" portable carbon dioxide indicator and analyzer.—Instrument Engineering Service, Johnson Rd., Michigan City, Ind.

Circle **494** on inquiry card.

Correction: The catalog number in the advertisement of Robertshaw-Fulton Controls Co., which appeared on page 65 of the January, 1954 issue of *Instruments and Automation*, appeared upside-down. For those of you who did not turn the magazine to read the number, the Catalog (covering bellows assemblies in a wide range of materials) is AE-1400. For this catalog, circle 495 on inquiry card.

FULTON SYLPHON 50th ANNIVERSARY 1904-1954

Sylphon Control No. 999-T, used in bonderizing operation at Modern Tool and Die Co., Cleveland, Ohio.

Saves a man's time... and his skin

SYLPHON TEMPERATURE REGULATOR NO. 999-T — *Powerful, compact, accurate. Can be supplied with or without dial indicating thermometer. Ideal for many temperature control uses.*

TANKS OF HOT ACID solutions or hot water are real problems where temperature must be controlled manually. Use of hand thermometers is risky, often causes serious injury.

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For more information circle **157** on inquiry card.

MANUFACTURERS' NEW LITERATURE

Nephelometry. New 6-page illustrated Bulletin B-226 presents principles of operation of Coleman Nephelometer and comparison of nephelometry method with gravimetric method.—Burrell Corp., 2223 Fifth Ave., Pittsburgh, Pa.

Circle **496** on inquiry card.

Recording Viscometers. New 8-page illustrated Bulletin V-1000E presents principle of operation, features, and sensitivity of maker's viscometers for recording or recording-controlling viscosity in industrial plants.—Norcross Corp., Newton 58, Mass.

Circle **497** on inquiry card.

X-ray Quantometer. New 4-page illustrated "Spectrographer's News Letter," Vol. VI, No. 4, features articles on nondispersive X-ray fluorescent analysis with maker's X-ray research "Quantometer," description of facilities and service of maker's new laboratory, and new angle rotary gap. —Applied Research Labs., P.O. Box 1710, Glendale, Calif.

Circle **498** on inquiry card.

Electron Microscope. New 2-page illustrated bulletin describes maker's new "EM-75" medium-power electron microscope and previews new high-resolution emission microscopes for metallurgical studies of metals and metallic oxides during heating.—North American Philips Co., Inc., Mt. Vernon, N. Y.

Circle **499** on inquiry card.

Oxygen Analysis. New 1-page Bulletins AD-610 and 702 treat use of maker's oxygen anlyzer in measuring and controlling oxygen content of industrial gases and chemicals.—Arnold O. Beckman, Inc., 1020 Mission St., S. Pasadena, Calif.

Circle **500** on inquiry card.

Ultraviolet Monochromator. New 4-page illustrated Bulletin XL presents description and applications of maker's vacuum ultraviolet monochromator.—Baird Associates, Inc., 33 University Rd., Cambridge, Mass.

Circle **501** on inquiry card.

Differential Colorimeter. New 1-page illustrated bulletin describes and lists specifications and applications of maker's "Colormaster" differential colorimeter for paints, pigments, slurries, solutions.—Manufacturers Engineering and Equipment Corp., 2115 Stratford Ave., Willow Grove, Pa.

Circle **502** on inquiry card.

Spectrograph. New 2-page illustrated Bulletin 189-53 presents specifications and description of maker's "L251-15" intermediate two-lens quartz spectrograph for production control of nonferrous alloys.—Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.

Circle **503** on inquiry card.

Automatic Titrator. New 2-page Data Sheet K-22-217 presents application data for maker's automatic titrator in rapidly determining crystalline vitamin B 12.—Beckman Instruments, Inc., S. Pasadena, Calif.

Circle **504** on inquiry card.

Industrial Gas Analysis. New Bulletins AD-608 and 701 describe role of oxygen in catalytic cracking process during regeneration of catalyst, importance of oxygen control, and maker's sampling system for introducing standardization gases.—Arnold O. Beckman, Inc., 1020 Mission St., S. Pasadena, Calif.

Circle **505** on inquiry card.

MOISTURE

Moisture Testers. New 4-page illustrated bulletin, "Important Message, January 1954," describes company's facilities, products and staff that produce moisture measuring, recording, and regulating instruments.—Hygrotester Inc., 101 Henry St., Brooklyn, N. Y.

Circle **506** on inquiry card.

Moisture Control. New 6-page illustrated issue (Feb. 1954) of "Important Message," discusses method of measuring and regulating basis-weight and caliper with maker's moisture tester.—Hygrotester Inc., 101 Henry St., Brooklyn, N. Y.

Circle **507** on inquiry card.

WATER TREATMENT

Water Treatment. New 4-page illustrated issue (Vol. 5, No. 1) of "The Courier," describes application of maker's chemical-feeding equipment

BOOST PUMPS

Boost 100 PSI. air pressure to 10,000 PSI, fluid pressure for $173.25 (FOB Gardena, Calif.). Eight standard models for output fluid pressures of 1,000 to 30,000 PSI. Special models for lower or higher pressures.

Applicable wherever low volume output at high pressures is the requirement. For oil or water service. Complete power packages also available. Send for bulletins.

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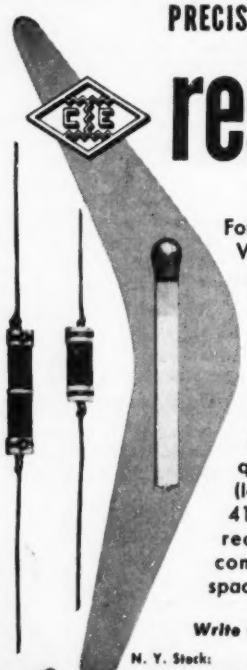

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in small water-purification plants. 2-page Data Sheet 24 is fluoridation nomogram applicable to all flows and all fluoride dosages.—B-I-F Industries, Inc., Providence 1, R. I.

Circle **508** on inquiry card.

Demineralizers. New 20-page illustrated Catalog 127 presents principles of operation and construction of maker's line of mixed-bed, two-bed, and four-bed demineralizers for lab, hospital, and industry use.—Barnstead Still & Sterilizer Co., 244 Lanesville Terrace, Forest Hills, Boston, Mass.

Circle **509** on inquiry card.

Chlorination Apparatus. New 10-page illustrated bulletin describes operation and features of maker's line of chlorination waste-treatment equipment.—Wallace & Tiernan, Inc., 25 Main St., Belleville, N. J.

Circle **510** on inquiry card.

AIR

Smoke Photometer. New 4-page Bulletin JM-1000 presents principles, operation, features, and accessories for new "Sinclair-Phoenix Forward-Scattering Smoke Photometer" for measurement of mass concentration (dust load) of particulate matter in atmosphere.—Phoenix Precision Instrument Co., 3803 N. Fifth St., Phila., Pa.

Circle **511** on inquiry card.

Smoke Alarm. New 2-page Bulletin 110 lists features, principle and operation of maker's "Model M" phototube-type smoke alarm.—Standard Instrument Corp., 350 Fifth Ave., New York, N. Y.

Circle **512** on inquiry card.

Electronic Precipitator. New 4-page illustrated bulletin describes and gives typical industrial applications of maker's new "Electro-Staynew" precipitator for air filtering.—Dollinger Corp., 56 Centre Pk., Rochester, N. Y.

Circle **513** on inquiry card.

SURFACE

Surface Roughness. New 8-page illustrated issue (Vol. 3 No. 3) of "Brush Strokes" covers features, construction, design, and calibration of maker's "Surfindicator" for measuring surface roughness. Includes basic definitions and principles.—Brush Electronics Co., 3322 Perkins Ave., Cleveland, Ohio.

Circle **514** on inquiry card.

Surface Roughness. New 8-page illustrated Bulletin LT89 presents maker's surface-roughness measuring instrument—Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.

Circle **515** on inquiry card.

Surface Roughness. New 4-page bulletin describes and gives price of new 64-page handbook on surface roughness designation, control and inspection, with back cover mounting of 24 specimens typical of various machine finishes.—Surface Checking Gage Co., Hollywood 28, Calif.

Circle **516** on inquiry card.

NEW

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FIXED-OUTPUT REGULATOR

Designed Especially for Instrument Air Supply Service

Kendall's New Model 50 is ideal for flow up to 10CFM or dead-end service because of its sturdy, tamper-proof construction combined with the filter-dripwell feature and drift-free characteristics.

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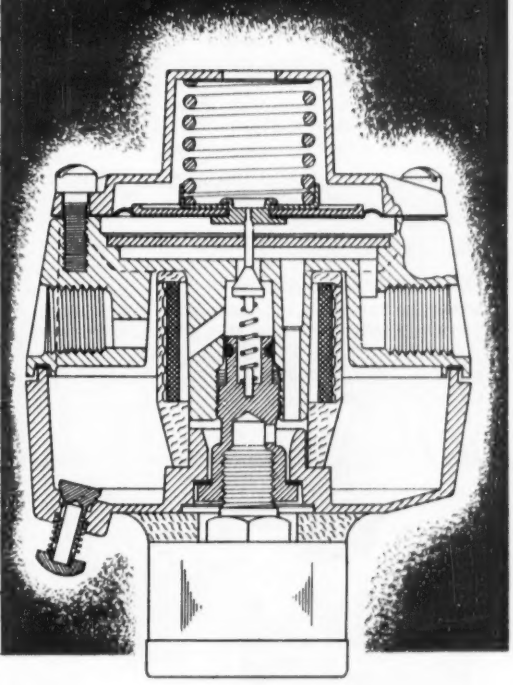

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For use where frequent adjustment of output pressure is required. Can be either panel or pipe mounted. Equipped with bronze threaded bushing for hex head adjustment screw or handwheel screw. Available in ranges from 2 to 100 p.s.i.

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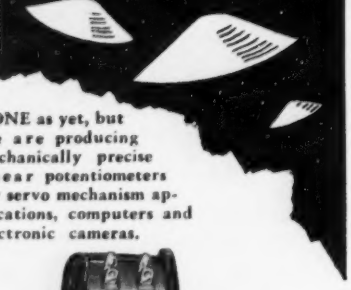
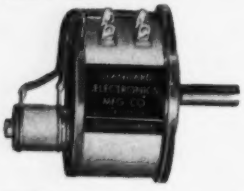
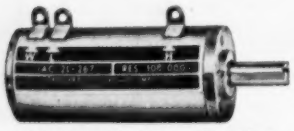


NONE as yet, but we are producing mechanically precise linear potentiometers for servo mechanism applications, computers and electronic cameras.



MODEL HB-3 3 turn potentiometer. 1.82 inches diameter. Resistance values up to 150,000 ohms. Linearity tolerance ±.5%, lower if necessary. Mechanical and electrical rotation 1080°. Ganging and mounting as ordered.



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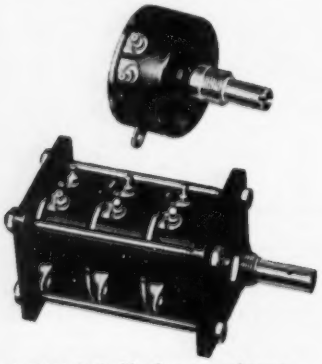

MODEL RAB Single turn resistance values to 100,000 ohms. Diameter 1-5/16". Linearity accuracies to .1%. Ganging as required. Bearings front and rear. Adaptable to remote positioning and indicating applications.

Precision engineered potentiometers to your specifications. ***For details write***

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MANUFACTURERS' NEW LITERATURE

OPTICS

Optical Aligning. New bulletin announces maker's new method of aligning generators, turbines, shafts, bearings, etc. by means of optical instruments and contrasts new method with old. Bulletin 815 details information on method, instruments, and accessories.—Farrand Optical Co., Inc., Bronx Blvd. & E. 238 St., New York, N. Y.

Circle **517** on inquiry card.

Cameras. New 12-page illustrated Catalog 4007-1-53-25M-AA presents maker's line of 35-mm. cameras.—Bolsey Corp. of America, 118 E. 25 St., New York, N. Y.

Circle **518** on inquiry card.

Photogrammetric equipment. New 28-page Catalog F-301 presents description and engineering data on maker's photogrammetric equipment, including Multiplex mapping instruments such as reduction printers, projectors, and tracing tables for forming stereoscopic scale models.—Bausch & Lomb Optical Co., 635 St. Paul St., Rochester, N. Y.

Circle **519** on inquiry card.

Optical Parts. New 16-page illustrated Catalog 5 presents maker's lenses, mirrors, prisms, spectroscopes, telescopes and accessories.—Laboratory Optical Co., Plainfield, N. J.

Circle **520** on inquiry card.

Textile Microscopes. New 4-page illustrated Bulletin B22-1253 includes description, uses, and data for maker's textile microscopes for identification and inspection of fibers.—American Optical Co., Instrument Div., Buffalo 15, N. Y.

Circle **521** on inquiry card.

MOTORS, SERVOS

Synchros, Servos, Resolvers. New 4-page illustrated catalog lists characteristics and specifications of maker's 116 types of synchros, servo motors, and resolvers. Includes 6 detailed tables covering functions, ratings, etc.—Ketay Mfg. Corp., 555 Broadway, New York, N. Y.

Circle **522** on inquiry card.

Servo Motors. New 4-page Bulletin 2395-4 presents description and specifications of maker's miniature a-c. precision servo motors and tachometer generators.—G-M Laboratories, Inc., 4300 N. Knox Ave., Chicago, Ill.

Circle **523** on inquiry card.

Frac.-hp. Motors. New 24-page illustrated brochure presents performance charts and specifications of maker's control motors, including low-inertia servo motors and synchronous motors.—Ford Instrument Co., 31-10 Thomson Ave., Long Island City, N. Y.

Circle **524** on inquiry card.

Motors and Controls. New 28-page illustrated Catalog GE2b presents technical data, description and features of maker's line of products for plant engineers, including motors, controls, heating devices, instruments, lighting equipment, rectifiers, regulators, relays, switches, testing and welding equipment.—General Electric, Schenectady 5, N. Y.

Circle **525** on inquiry card.

Motors, Relays, Counters. New 32-page illustrated issue of "This Month" (Feb.-March) features descriptions and specifications for distributor's audio and television equipment, photoelectric cells, test apparatus, motors, valves, relays, lab apparatus, etc.—Herbach & Rademan Inc., 1204 Arch St., Phila., Pa.

Circle **526** on inquiry card.

Reed-controlled Synchronous Motors. New 4-page illustrated bulletin lists features, specifications and performance curves of maker's reed-controlled d-c. motors and timers.—Amglo Corp., 2037 W. Division St., Chicago, Ill.

Circle **527** on inquiry card.

Frac.-hp. Motors. New 4-page illustrated issue (Vol. 34, No. 1) of "Motorgram" discusses use of maker's reducer motor in ultra-sensitive d-c breaker amplifier, and describes application of small motors to various products.—Bodine Electric Co., 2250 W. Ohio St., Chicago, Ill.

Circle **528** on inquiry card.

Miniature Motor. New 2-page illustrated Bulletin 900 gives description, features, and dimensions of maker's "Type SS Moto-Mite" miniature permanent-magnet d-c. motor.—Globe Industries, Inc., 1784 Stanley Ave., Dayton, Ohio.

Circle **529** on inquiry card.

TEST CHAMBERS

Explosion Chamber. New 4-page illustrated Bulletin 3370 gives specifications, construction and test procedures for maker's new explosion chamber.—Tenney Engineering, Inc., 26 Avenue B, Newark, N. J.

Circle **530** on inquiry card.

Environmental Equipment. New 24-page brochure outlines activities, membership, classifications, and publications of the Institute of Environmental Equipment Manufacturers.—Dr. George D. Wilkinson, Gen. Mgr., Institute of Environmental Equipment Mfg., 30 Church St., New York, N. Y.

Circle **531** on inquiry card.

POWER SUPPLIES

Power Supplies. New 8-page illustrated bulletin presents technical data for maker's a-c. and d-c. regulated power supplies, including miniature "Model 302."—Allied Engineering Div., Allied International, Inc., Connecticut & Richards Ave., S. Norwalk, Conn.

Circle **532** on inquiry card.

Power Supply. New 2-page illustrated Bulletin VF presents maker's "Type VFDD" power supply and demodulator unit.—Doelcam Corp., Soldiers Field Rd., Boston, Mass.

Circle **533** on inquiry card.

Automatically Average

Your

Temperature Readings

economically with the

Instantaneous Automatic Arithmetic Average

TEMPERATURE COMPUTORS

- Will handle from 6 to 30 thermocouples
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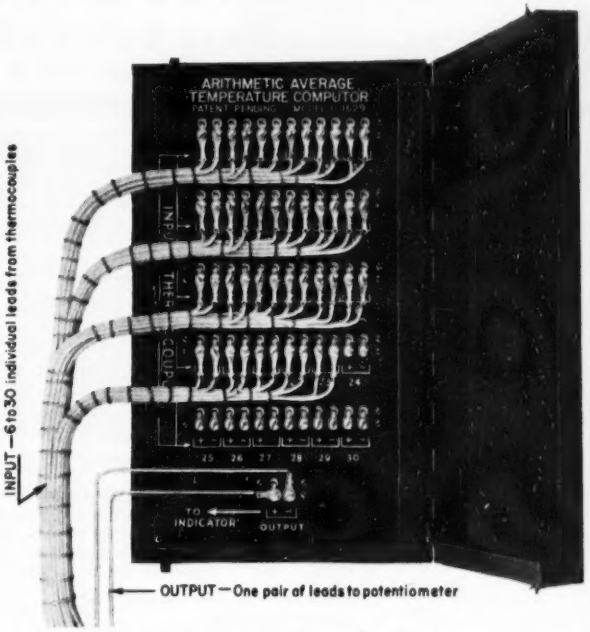
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INPUT — 6 to 30 individual leads from thermocouples
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OUTPUT — One pair of leads to potentiometer

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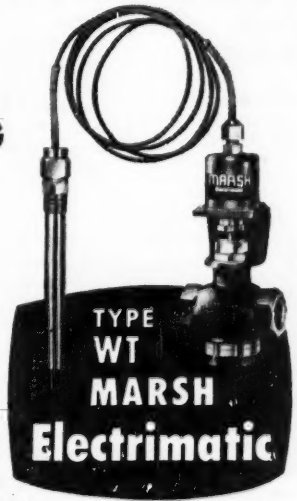

A temperature actuated regulating valve you can depend on—the Marsh-Electrimatic Type WT for pressures up to 150 psi; water, brine or steam. It opens as temperature rises, closes as temperature falls, to give an ideal, smooth, modulated control. Can be mounted in any position; serviced without breaking connections. Seat beads are monel to eliminate wire drawing. Sturdy, two-ply bellows assures extra service life. Temperature ranges of 20°F.-60°F.; 60-100, 100-140, 140-180, 160-220. All standard sizes from ⅜" through 4". All styles of temperature bulbs.

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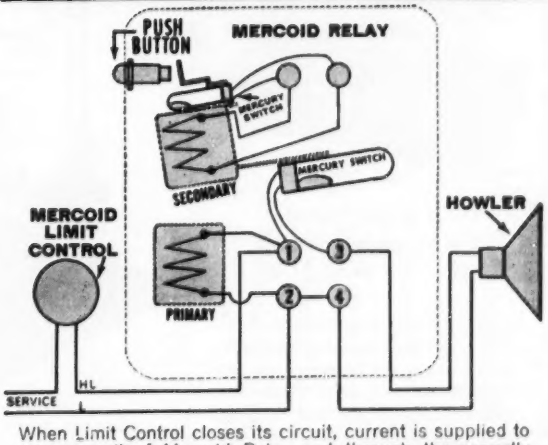

When Limit Control closes its circuit, current is supplied to primary coil of Mercoid Relay and through the normally closed mercury switch to the "Howler" (alarm). To stop "Howler," operator pushes in "push button" which manually raises relay secondary and breaks circuit to "Howler." Secondary is held up by magnetic repulsion until condition is corrected. When limit control opens the primary circuit of relay, secondary coil drops to normal position and relay is automatically ready for another operation.

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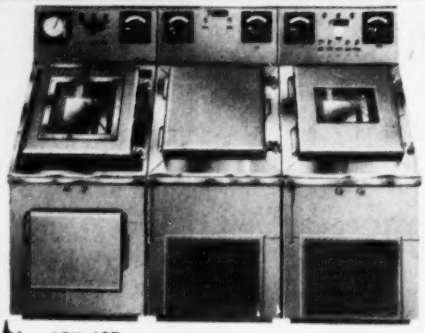

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FEATURES:
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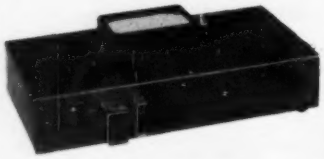
Spectrophotometer



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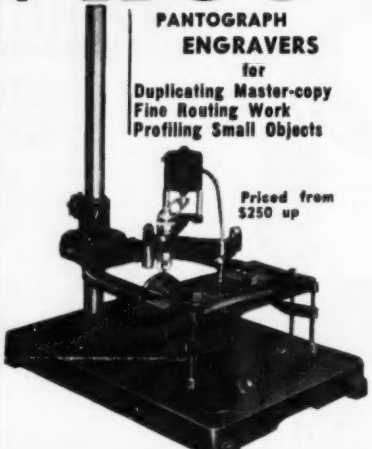

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NEW LITERATURE

AUDIO, RADIO

Hi-Fi, Electronic Instruments, Components. New 56-page illustrated Catalog Supplement 137 lists and describes distributor's line of tape recorders, antennas, sound systems, television components and test equipment, and Hi-Fi components.—Allied Radio, 100 N. Western Ave., Chicago, Ill.

Circle **534** on inquiry card.

Hi-Fi, Instrument Kits. New 12-page illustrated "Winter Flyer" gives features of maker's electronic kits for VTVM, oscilloscope, high-fidelity equipment, etc.—Heath Co., Benton Harbor, Mich.

Circle **535** on inquiry card.

TV Servicing. New 4-page issue No. 1 of "Technician's Timesaver" presents directions for adjusting video amplifier and troubleshooting tips.—Simpson Electric Co., 5200 W. Kinzie St., Chicago, Ill.

Circle **536** on inquiry card.

Video Generator. New 1-page illustrated Catalog Sheet 650 C covers maker's new "Model 650 C" white-dot generator compatible for color or black-and-white TV registration adjustment.—Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio.

Circle **537** on inquiry card.

Hi-Fi Amplifier. New 2-page illustrated Bulletin 121311 presents maker's "Type 121-A Dynaural" equalizer-preamplifier for high-fidelity sound reproduction.—Hermon Hosmer Scott, Inc., 385 Putnam Ave., Cambridge, Mass.

Circle **538** on inquiry card.

Extrasensitive TV Camera Tube. New 12-page illustrated Tentative Data Sheet 6326 presents technical data and performance charts, of maker's new "6326 Vidicon" small camera tube with high sensitivity to permit televising motion-picture film.—Tube Dept., RCA, Harrison, N. J.

Circle **539** on inquiry card.

FM Signal Generator. New 2-page illustrated bulletin presents features and specifications of maker's "Model 100C" FM signal generator of 30 to 40 Mc. and 150 to 174 Mc. as well as standard FM and TV bands.—New London Instrument Co., 82 Union St., New London, Conn.

Circle **540** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Magnetic Amplifiers. New 8-page illustrated Technical Data Bulletin 52-601 provides definitions of terms, functions of magnetic amplifiers, theory of operation, application information, specifications and characteristics of maker's transductor "Magamps" magnetic amplifier.—Westinghouse Electric Corp., Materials Div., East Pittsburgh, Pa.

Circle **541** on inquiry card.

Contact Protectors. New 4-page illustrated Bulletin 558 explains damaging effects of arcing, mechanism of arc suppression, and d-c. and a-c. applications of maker's selenium rectifiers as contact protectors.—Federal Telephone and Radio Co., Selenium-Intelin Dept., 100 Kingsland Rd., Clifton, N. J.

Circle **542** on inquiry card.

Insulation Testing. New 4-page issue (Vol. 10, No. 1), of "Instrument News" features articles on maker's corona testing equipment, new model impulse-type cable-fault locating transmitter, application engineering notes, and transformer turn-ratio test set.—James G. Biddle Co., 1316 Arch St., Phila., Pa.

Circle **543** on inquiry card.

Precision Frequency Measurement. New 8-page bulletin "Application of Counter Techniques to Precision Frequency Measurements," discusses principles of precision frequency measurement, limitations of frequency range extensions by heterodyne method, means of extending frequency range into vhf and uhf bands, and describes typical converter for range 40-150 Mc. and new meter for use up to 42 Mc.—Berkeley Div., Beckman Instruments, Inc., 2200 Wright Ave., Richmond, Calif.

Circle **544** on inquiry card.

Phase-shift Measurement. New 4-page "Laboratory Report" No. 8 features articles describing method of measuring phase shift through computing magnetic amplifier using "Type 7000-A" primary phase standard. Includes theory, plus article on measuring small angles in vicinity of zero degrees with "Type 320-AB" phase meter.—Technology Instrument Corp., 531 Main St., Acton, Mass.

Circle **545** on inquiry card.

Tachometer Generator. New 4-page illustrated issue (Vol. 5, No. 3-4) of "hp Journal" describes maker's new 60-cycle-per-revolution generator for precision tachometry measurement.—Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

Circle **546** on inquiry card.

Pulse Generator. New 2-page illustrated bulletin presents maker's pulse generator with pulse width from 1 to 250 microseconds.—Marconi Instruments Ltd., 23-25 Beaver St., New York, N. Y.

Circle **547** on inquiry card.

Traveling-wave-tube Wide-band Amplifier. New 2-page illustrated data sheet presents tentative performance characteristics of maker's "HA-2/4-50/20-1" developmental wide-band traveling-wave-tube amplifier.—Huggins Laboratories, 700 Hamilton Ave., Menlo Park, Calif.

Circle **548** on inquiry card.

Decade Shunt. New 2-page illustrated bulletin presents description, specifications, and ordering information for maker's new "Model 2008" decade shunt for use with "Model 200" electrometer.—Keithley Instruments, 3868 Carnegie Ave., Cleveland, Ohio.

Circle **549** on inquiry card.

Electric Testing Instruments. New 8-page illustrated Bulletin 10A gives description, features and types of maker's electric testing instruments, including insulation resistance testing, dielectric strength testers, tachometers and polygraphs (lie detectors).—Associated Research, Inc., 3758 W. Belmont Ave., Chicago, Ill.

Circle **550** on inquiry card.

Transfer Volt-Ammeter. New 4-page bulletin describes maker's transfer volt-ammeter with 0.05-percent accuracy, its features and operating instructions.—Charles Engelhard, Inc., 850 Passaic Ave., E. Newark, N. J.

Circle **551** on inquiry card.

Volt-ohm-milliammeter. New 2-page bulletin presents maker's "Model 262" volt-ohm-milliammeter with sensitivity of 20,000 ohms per volt (5000 ohms per volt a-c.). Price reduction also announced.—Simpson Electric Co., 5200 W. Kinzie St., Chicago, Ill.

Circle **552** on inquiry card.

Conductance Tester. New 4-page illustrated Bulletin 2B describes "Model 269 Vibrotest" and application for testing electrical conductance of floors, personnel and equipment in hazardous atmospheres as in hospitals, chemical, and ordnance plants.—Associated Research, Inc., 3766 E. Belmont Ave., Chicago, Ill.

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VTVM. New 1-page illustrated bulletin includes description, construction

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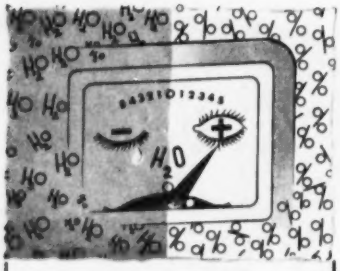

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NEW LITERATURE

and specifications of maker's "Model 1520" vacuum-tube a-c. voltmeter for from 15 cps. to 250 kc.—Communication Measurements Laboratory, Inc., 350 Leland Ave., Plainfield, N. J.
Circle **554** on inquiry card.

Panel Instruments. New 4-page illustrated bulletin covers features, dimensions, ranges, and resistances for maker's 2½-in. ruggedized "Model R-210" panel instruments.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.
Circle **555** on inquiry card.

UHF Attenuator. New 4-page illustrated bulletin presents description, rating, and specifications of maker's turret attenuator, attenuator pad, and coaxial line termination. Also block diagram of lab setup for measurement of attenuation.—Stoddart Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood, Calif.
Circle **556** on inquiry card.

Vacuum-tube Electrometers. New 8-page illustrated bulletin presents circuit schematic, application, and specifications of maker's vacuum-tube electrometers and accessories.—Keithley Instruments, 3868 Carnegie Ave., Cleveland, Ohio.
Circle **557** on inquiry card.

Db Panel Meters. New 2-page engineering data sheet presents specifications and dimensions of maker's 1½-in. square or round decibel meters.—International Instruments Inc., P. O. Box 2954, New Haven, Conn.
Circle **558** on inquiry card.

High-current Test Instruments. New 4-page Catalog 154 presents specifications and industrial applications of maker's line of portable high-current test instruments for testing motors, relays, etc.—Multi-Amp Corp., 10 3rd St., Newark, N. J.
Circle **559** on inquiry card.

Continuity Testers. Three new bulletins list specifications, features and applications of maker's small, portable continuity testers for servicemen, electricians, etc.—Revan Products Co., Box 549, Binghamton, N. Y.
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Sweep-frequency Generators. New 1-page illustrated bulletin lists features and specifications of maker's "Sweepmaster" sweep-frequency generators for operation from 100 kc. to 75 Mc.—Manufacturers Engineering & Equipment Corp., Hatboro, Pa.
Circle **561** on inquiry card.

Panel-mount VTVM. New 2-page illustrated bulletin describes maker's new "Type A" panel-mounting a-c. vacuum-tube voltmeter.—Trio Laboratories, P. O. Box 143, Wantagh, N. Y.
Circle **562** on inquiry card.

Snap-around Volt-ammeters. New 4-page illustrated Catalog 134 presents features and applications of maker's "Amprobe" pocket sized, snap-around volt-ammeter.—Pyramid Instrument Corp., Lynbrook, N. Y.
Circle **563** on inquiry card.

RESISTORS, POTENTIOMETERS

Precision Potentiometers. New 2-page illustrated bulletin lists design features, descriptions, specifications and ratings of maker's "RV ⅞" miniature trimmer potentiometer and "RVP ⅞" miniature precision potentiometer.—Technology Instrument Corp., 531 Main St., Acton, Mass.
Circle **564** on inquiry card.

Wire-wound Resistors. New 6-page Catalog Section R presents characteristics, construction, and ordering information for maker's precision wire-wound resistors. Includes tables of characteristics.—Daven Co., 191 Central Ave., Newark, N. J.
Circle **565** on inquiry card.

Wire-wound Resistors. New 4-page Catalog Bulletin D-1 gives characteristics, applications, ratings, tolerances, and temperature coefficient for maker's precision wire-wound resistors of MIL type.—International Resistance Co., 401 N. Broad St., Phila., Pa.
Circle **566** on inquiry card.

Rheostats. New 2-page issue (Dec. 1953) of "Ohmite News" features descriptive article on tandem rheostat assemblies. Also resistor assortment cabinets, ribbon-wound resistors, and heat-control rheostats.—Ohmite Mfg. Co., 3603 Howard St., Skokie, Ill.
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Tape Resistor. New 1-page bulletin presents maker's carbon resistors in tape form for printed circuitry, including features and use.—Sanders Associates, Inc., 137 Canal St., Nashua, N. H.

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Potentiometers, Rheostats. New 20-page illustrated Catalog 79-7 lists electrical and mechanical features and accessories for maker's carbon and wire-wound potentiometers and rheostats.—P. R. Mallory & Co., Inc., Frankfort, Ind.

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Wirewound Resistors. New 36-page illustrated Catalog 101 presents wire sizes, types of winding, cases, performance and ratings of maker's wirewound resistors.—Sprague Electric Co., North Adams, Mass.

Circle **570** on inquiry card.

CONNECTORS

Multi-contact Connectors. New 4-page bulletin lists distributor's large line of AN connectors and inserts and RF coaxial connectors with JAN number.—Hudson Radio & Television Corp., 48 W. 48 St., New York, N. Y.

Circle **571** on inquiry card.

Multicontact Connectors. New 2-page bulletins cover descriptions, dimensions and ratings of maker's new terminal boards, "Series 20" rectangular connectors with polarizing guide pin and socket, and "Series 16 T" rectangular contacts with turret terminals.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.

Circle **572** on inquiry card.

Miniature Connector. New 2-page illustrated Bulletin page 6 covers features and ratings of maker's "Series 20" miniature rectangular connectors with polarizing "Screwlock" guide pin and socket.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.

Circle **573** on inquiry card.

Multicontact Connectors. New 8-page illustrated Bulletin AN-E-1 gives technical data and dimensions of maker's "Type AN" vibration-proof plugs.—Cannon Electric Co., 3209 Humboldt St., Los Angeles, Calif.

Circle **574** on inquiry card.

Plugs, Jacks, Switches. New 24-page illustrated Catalog 53-A presents maker's line of switches, plugs, jacks, phone tips, adapters, clips, leads and hardware.—Herman H. Smith, Inc., 2326 Nostrand Ave., Brooklyn, N. Y.

Circle **575** on inquiry card.

SWITCHES, RELAYS

Oil-tight Switches, Lights. New 16-page illustrated Bulletin GEA-5779B presents principle, applications, and dimensions for maker's large line of oil-tight push buttons, indicating lights, selector switches and accessories.—General Electric Co., Schenectady 5, N. Y.

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High-speed Relays. New 8-page illustrated Bulletin 337-329 includes

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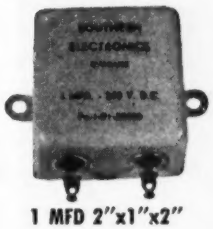

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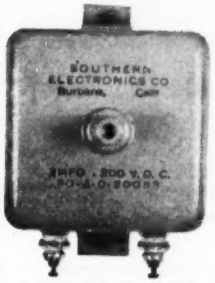

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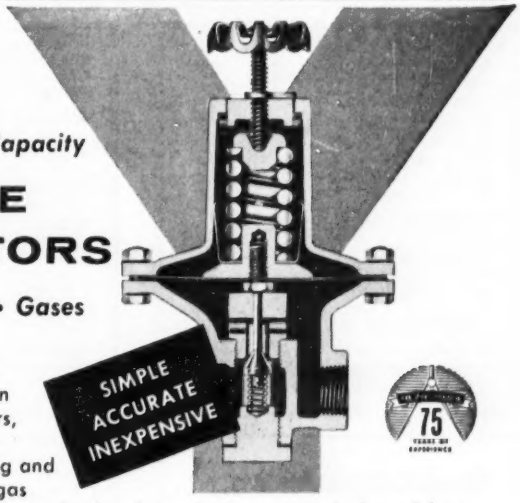

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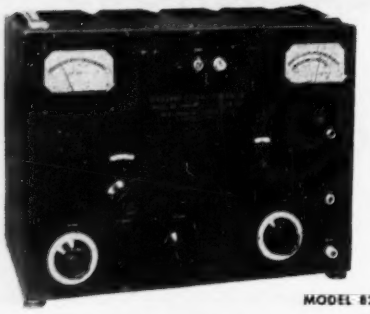

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NEW LITERATURE

applications, speed of operation under various conditions, general characteristics, nomograph and equations for calculating component values for spark suppression circuit, and ratings of maker's new ultra-high-speed "Millisec" relays.—Stevens-Arnold Inc., 22 Elkins St., S. Boston, Mass.

Circle **577** on inquiry card.

Sealed Relays. New 2-page Bulletin 7500-9-53 gives specifications of maker's new "6000 Series" hermetically sealed miniature relays.—U. S. Relay Co., 1744 Albion St., Los Angeles, Calif.

Circle **578** on inquiry card.

Enclosed Reset Switch Assemblies. New 2-page illustrated Data Sheet 69 treats maker's enclosed reset switch assemblies, including description and characteristics.—Micro Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **579** on inquiry card.

Surge and Impact Switches. New 2-page Bulletins 10 and 11 give principle of operation, applications, models and specifications of maker's "Surj-Switch" and "Impak-Switch" for counting and safety use.—Autotron Co., P. O. Box 722, Danville, Ill.

Circle **580** on inquiry card.

Two-step Delay Relays. New 4-page illustrated Bulletin SR4 lists operating sequences, typical applications, features, wiring diagrams for maker's new two-step pneumatically-controlled time-delay relay.—A'G'A Div., Elastic Stop Nut Corp. of America, Elizabeth 3, N. J.

Circle **581** on inquiry card.

Mercury Switches. New 12-page illustrated Catalog 90 covers maker's five families of mercury switches, classed as protected, heavy duty, general use, small, and sensitive switches. Includes dimensions, rating, and application.—Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport Ill.

Circle **582** on inquiry card.

Relays and Solenoid Contactors. New 12-page illustrated bulletin covers maker's solenoid contactors. 2-page bulletins cover heavy-duty relay and angle-mounted latching relays.—Leach Relay Co., 5915 Avalon Blvd., Los Angeles 3, Calif.

Circle **583** on inquiry card.

Magnetic Contactors. New 8-page illustrated Bulletins 501 & 502 present construction, dimensions and applications of maker's magnetic contactors.—Federal Electric Products Co., 50 Paris St., Newark, N. J.

Circle **584** on inquiry card.

ELECTRONIC COMPONENTS

Miniature Inductors. New 1-page bulletin lists features, specifications and ordering data for maker's miniature inductors for 2.2 to 220 mh.—Mico Instrument Co., 80 Trowbridge St., Cambridge, Mass.

Circle **585** on inquiry card.

Twin-T Filters. New 4-page bulletin covers description, features, and performance of maker's "Series 500" twin-T resistance-capacitance filter networks for frequency-stabilization and response-modification use at low frequencies.—White Instrument Labs., 203 Riverside Dr., Austin, Texas.

Circle **586** on inquiry card.

Transistor-type Transformers. New 12-page illustrated catalog presents maker's line of hermetically sealed miniature transistor-type transformers.—Microtran Co., 84-11 Rockaway Beach Blvd., N. Y.

Circle **587** on inquiry card.

Selenium Rectifiers. New 4-page illustrated issue RN-1053 of "Rectifier News" features articles on selenium rectifiers as commutator eliminators, color-TV rectifiers, and linearity improvement circuit for photoelectric cells. New 4-page reprint is "Survey of Various Types of Selenium Rectifiers."—International Rectifier Corp., El Segundo, Calif.

Circle **588** on inquiry card.

Plug-in Circuits. New 12-page illustrated Catalog C-3 covers features, specifications and types of maker's packaged plug-in circuits—amplifiers, oscillators, gates, delays, etc. Includes circuit schematics.—Electronic Engineering Co., 180 S. Alvarado St., Los Angeles, Calif.

Circle **589** on inquire card.

Electron Tubes. New 3-page data sheet gives technical information on application of "6x4" diode tubes in capacitor-input circuits.—CBS Hytron, Danvers, Mass.

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High-vacuum Rectifier. New 2-page illustrated Bulletin 3B24W gives characteristics and dimensions of maker's high-vacuum rectifier "3B24W."—Lewis and Kaufman, Ltd., 136 El Rancho Ave., Los Gatos, Calif.

Circle **591** on inquiry card.

Germanium Diodes. New 2-page illustrated Tentative Data Sheet IN67 lists characteristics and description of maker's "IN67-IN67-P" germanium crystal diode.—Raytheon Mfg. Co., Newton, Mass.

Circle **592** on inquiry card.

Crystal Diodes. New 2-page illustrated Tentative Data Sheets present technical data, rectifier service, and operating considerations for maker's new germanium point-contact crystal diodes, "Type 1N34-A, 1N55-A, 1N56-A and 1N58-A."—Tube Dept., RCA, Harrison, N. J.

Circle **593** on inquiry card.

Pentagrid Amplifier. New 4-page Tentative Data Sheet presents performance, charts, and drawings of maker's miniature "Type 6BY6" pentagrid amplifier.—Tube Dept., RCA, Harrison, N. J.

Circle **594** on inquiry card.

Capacitors. New 8-page illustrated issue (Vol. 28, No. 8) of "Experimenter" treats specifications, descriptions, and types of maker's precision adjustable capacitors of 10-100 uuf., and 100-1000 uuf.—General Radio Co., 275 Massachusetts Ave., Cambridge, Mass.

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NEW LITERATURE

Capacitors. New 24-page issue (Vol. 19, No. 1) of "Capacitor" features article on substitution units for troubleshooting and robot control for cars in crash tests. Also descriptions of maker's "Cub" and "UP" capacitors. —Cornell-Dubilier Electric Corp., Hamilton Blvd., S. Plainfield, N. J.

Circle **596** on inquiry card.

Autotransformer. New 12-page illustrated Bulletin 424-M presents features and specifications of maker's line of continuously adjustable "Variac" autotransformers.—General Radio Co., Cambridge 39, Mass.

Circle **597** on inquiry card.

MECHANICAL COMPONENTS

Instrument Ball Bearings. New 32-page illustrated Catalog 53 presents maker's precision instrument ball bearings including characteristics, tolerances, and ratings.—New Hampshire Ball Bearings, Inc., Peterborough, N. H.

Circle **598** on inquiry card.

Precision, Temperature-compensated Springs. New 8-page illustrated bulletin discusses factors to be considered in design and application of precision springs. 4-page bulletin covers use of new spring alloy to solve variable temperature problem; 1-page bulletin shows application of spring alloy in aircraft fuel flow system. 4-page bulletins describe drift in spring steel and spring alloy, "Iso-Elastic."—John Chatillon & Sons, 85 Cliff St., New York, N. Y.

Circle **599** on inquiry card.

Subminiature Blower. New 2-page bulletin presents maker's subminiature blower featuring motor and blower complete in 1 cu. in. with 3 cu. ft. per minute output.—Sanders Associates, Inc., 137 Canal St., Nashua, N. H.

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TUBING

Tubing, Cable Support. New 8-page illustrated Catalog 853 presents features, installations, and parts of maker's steel supporting structures for cable trough, instrument tubing trough, conduit, pipe and cables.—Rakit Corp., 711 S. 50 St., Phila., Pa.

Circle **601** on inquiry card.

Flexible Plastic Tubing. New 6-page illustrated Bulletin 264D-953 presents features and performance characteristics of "Tygon R3603" flexible plastic tubing.—Burrell Corp., 2223 Fifth Ave., Pittsburgh, Pa.

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SHOP EQUIPMENT

Aluminum and Stainless-steel Fabrication. New 2-page bulletins 140 and 141 describe facilities and services of fabricator of stainless steel and aluminum.—Falstrom Co., 97 Falstrom Ct., Passaic, N. J.

Circle **603** on inquiry card.

Wire Strippers. New 16-page illustrated Bulletin RWS-113 presents list of users of maker's wire-stripping equipment and includes statement of company's policy.—Rush Wire Stripper Div., Eraser Co., Inc., Syracuse 4, N. Y.

Circle **604** on inquiry card.

Work Benches. New 24-page illustrated bulletin describes maker's line of basic work benches with changeable work center tops, water, electricity and gas connections, and parts containers.—Alden Systems Co., Research Center, Westboro, Mass.

Circle **605** on inquiry card.

Coded-call Paging System. New 6-page illustrated Bulletin 1752 presents description, operation and features of distributor's "P-A-X Code Call" internal business telephone system for paging throughout plant.—Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago, Ill.

Circle **606** on inquiry card.

Soldering Irons. New 4-page illustrated Catalog 106 lists maker's line of industrial electric soldering irons—a total of 40 models of seven distinct types, including 13 new models.—Hexacon Electric Co., 179 W. Clay Ave., Roselle Park, N. J.

Circle **607** on inquiry card.

Ultrasonic Cleaning. New 4-page illustrated bulletin describes equipment, specifications, and application of ultrasonic generator to activation of cleaning baths.—Branson Instruments, Inc., 430 Fairfield Ave., Stamford, Conn.

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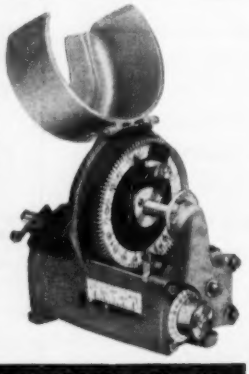

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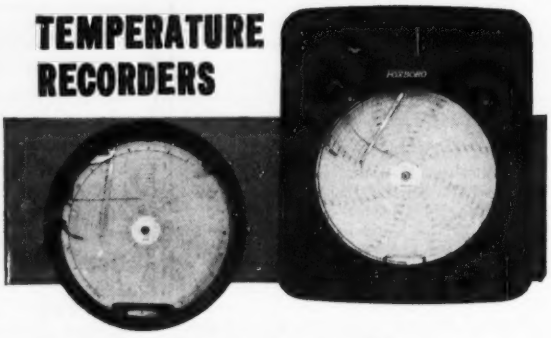

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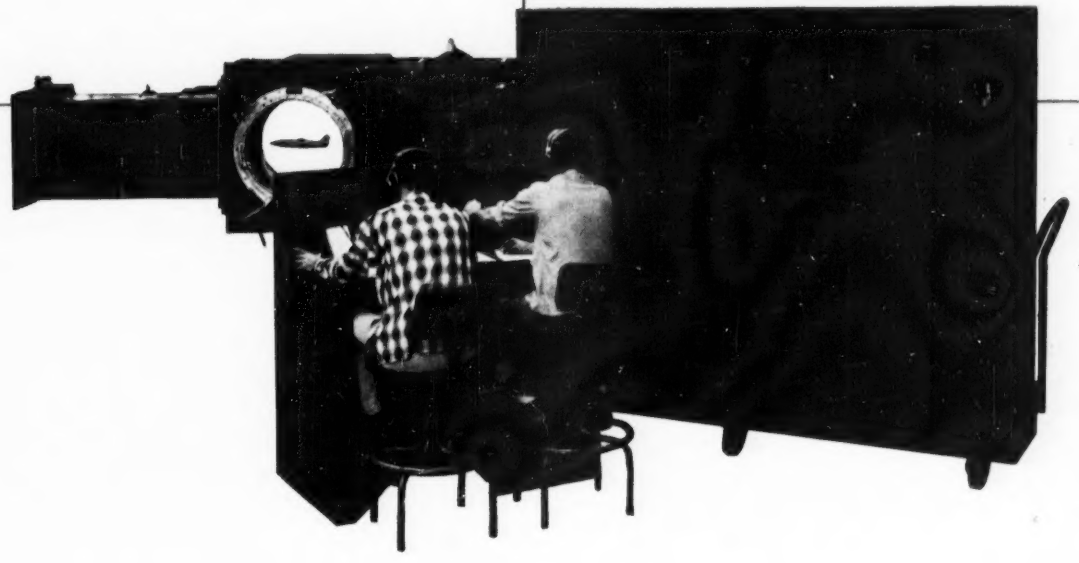

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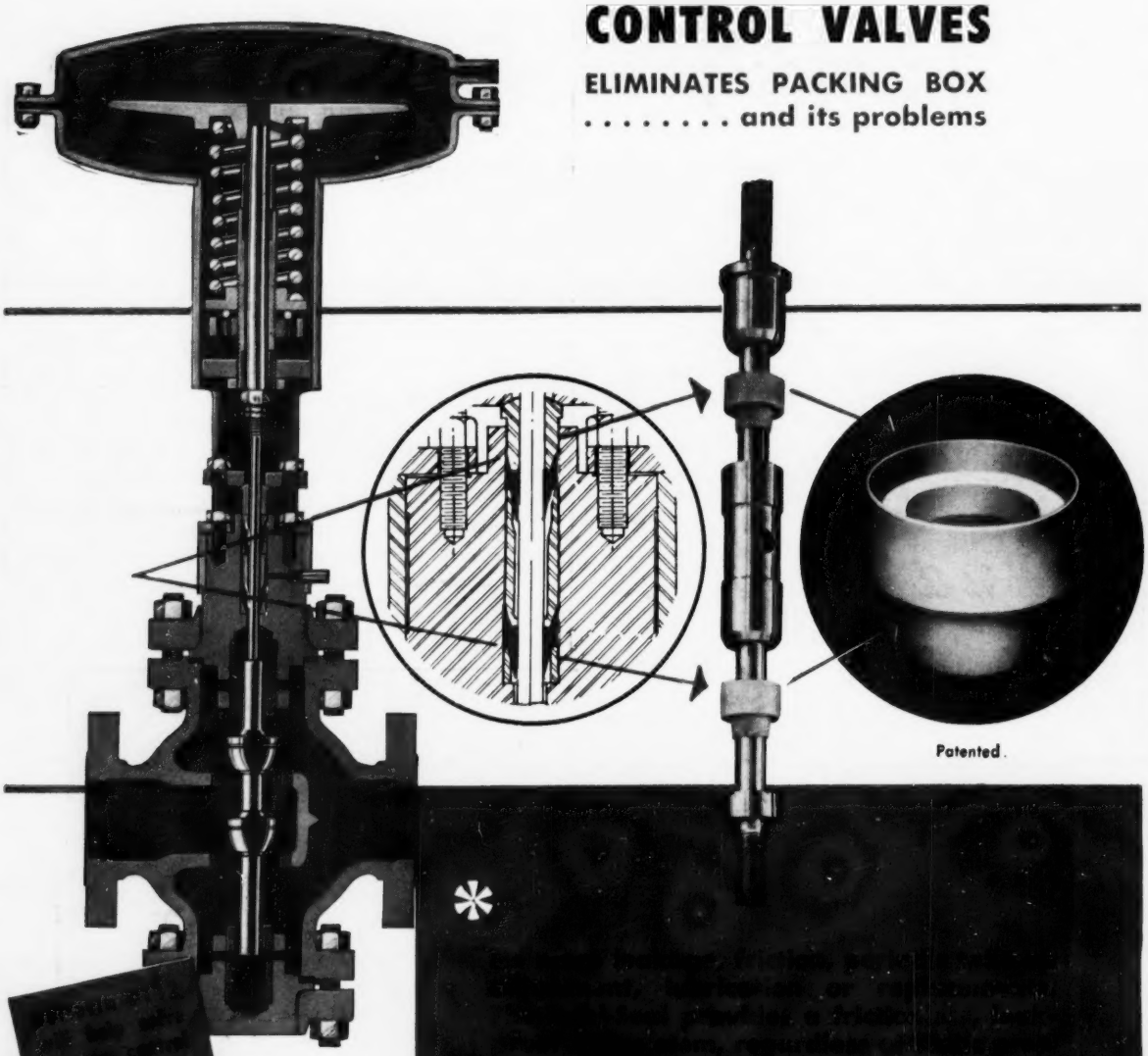

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